# CYCLOPHYLLIDEAN CESTODES FROM BIRDS IN BORNEO

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CONTENTS




## ABSTRACT

Twenty seven species of cestodes, collected from 20 species of birds in Borneo, are identified and described in the following order:

*Paronia bocki* Schmelz; *Raillietina echinobothrida* (Megnin); *R. johri* Ortlepp; *R. parviuncinata* Meggitt et Saw; *R. sequens* Tub. et Masil.; *R. allomyodes* Kótlan; *Raillietina* sp.; *R. siamensis* Schmelz; *Hymenolepis mahonae* nom. nov.; *Hymenolepis* sp.; *Fimbriaria fasciolaris* (Pallas); *Paricterotaenia burti* Sandeman; *Dilepis ardeolae* Singh; *Liga facile* (Meggitt); *Anomotaenia depressa* (Siebold); *A. nymphaea* (Schrank); *A. tringae* (Burt); *Parvitaenia* sp.; *Vitta rustica* (Neslobinsky); Dilepid sp.; *Kowalewskiella susanae* sp. nov.; *Ascometra* sp.; *Notopentorchis collocaliae* Burt; *Gyrocoelia perversa* Fuhrmann; Acoleid spp. (3).

Of these, two are new species, one is recorded from Asia for the first time, and the synonymy and taxonomy of each species is discussed. The descriptions are as complete as the material allowed and are supported by 60 text figures and 12 tables.

## INTRODUCTION

THE following cestodes form part of a collection of parasites collected from vertebrates by Dr. Robert E. Kuntz, United States Navy Medical Corps, in Borneo and sent to Dr. T. W. M. Cameron, Institute of Parasitology, Macdonald College, for identification. The species described are listed in systematic order. There are several new host-records and two new species are described. All drawings were made with the aid of a Wild drawing tube. Whole mounts were stained either in acetic acid alum-carmine or in Ehrlich's haematoxylin. Horizontal sections cut at 15 $\mu$, and transverse sections cut at 5–10 $\mu$, were stained in Ehrlich's haematoxylin and counterstained in eosin. Examination of rostellar hooks, sucker spines, and oncosphere hooks was facilitated by using Berlese fluid. Material prepared as whole mounts has been deposited in the collections of the British Museum (Natural History).

## HOST LIST

*APODIFORMES*

*Apus affinis* (J. E. Gray)
- *Anomotaenia depressa* (Siebold, 1836)
- *Notopentorchis collocaliae* Burt, 1938

*ANSERIFORMES*

*Anas boschas domestica* L.
- *Fimbriaria fasciolaris* (Pallas, 1781)

*CHARADRIIFORMES*

*Actitis hypoleucos* (L.)
- *Liga facile* (Meggitt, 1927)

*Charadrius leschenaultii* Lesson
- *Gyrocoelia perversa* Fuhrmann, 1899
- *Paricterotaenia burti* Sandeman, 1959
- *Raillietina* (*Paroniella*) *siamensis* Schmelz, 1941 (?)
- *Species* 1
- *Species* 2
- *Species* 3

*Numenius phaeopus* (L.)
- *Anomotaenia nymphaea* (Schrank, 1790)

*Tringa glareola* L.
- *Anomotaenia tringae* (Burt, 1940)
- *Kowalewskiella susanae* n. sp.
- *Raillietina* (*Raillietina*) *johri* Ortlepp, 1938 (?)

*CICONIIFORMES*

*Butorides striatus* (L.)
- *Dilepis ardeolae* Singh, 1952 (?)
- *Parvitaenia* sp.

*COLUMBIFORMES*

*Columba livia domestica* L.
- *Raillietina* (*Raillietina*) *sequens* Tubangui et Masiluñgan, 1937

*Treron curvirostra* (Gmelin)
- *Raillietina* (*Raillietina*) sp.

*Treron vernans* (L.)
- *Raillietina* (*Raillietina*) *allomyodes* Kótlan, 1921
- *Raillietina* (*Raillietina*) *johri* Ortlepp, 1938

*Streptopelia chinensis* (Scopoli)
- *Raillietina* (*Raillietina*) *sequens* Tubangui et Masiluñgan, 1937

*CUCULIFORMES*

*Cacomantis merulinus* (Scopoli)
- Dilepididae

**Centropus toulou* (P.L.S. Müller)
- *Ascometra* sp.

| | |
|---|---|
| *GALLIFORMES* | |
| *Gallus gallus* (L.) *dom.* | *Raillietina* (*Raillietina*) *echinobothrida* (Megnin, 1881) |
| | *Raillietina* (*Raillietina*) *parviuncinata* Meggitt et Saw, 1924 |
| *PASSERIFORMES* | |
| *Aegithina tiphia* (L.) | *Hymenolepis mahonae* nom. nov. |
| | *Raillietina* (*Raillietina*) *sequens* Tubangui et Masiluñgan, 1937 |
| *Anthreptes malacensis* (Scopoli) | *Hymenolepis* sp. |
| *Hirundo rustica* L. | *Vitta rustica* (Neslobinsky, 1911) |
| *Nectarinia calcostetha* Jardine | *Hymenolepis* sp. |
| *PICIFORMES* | |
| *Megalaima chrysopogon* (Temminck) | *Paronia bocki* Schmelz, 1941 |
| | *Raillietina* (*Paroniella*) *siamensis* Schmelz, 1941 |
| *Meiglyptes tukki* (Lesson) | *Raillietina* (*Paroniella*) *siamensis* Schmelz, 1941 |

* *Centropus toulou* (P. L. S. Müller) is not recorded from Borneo (Smythies: *The Birds of Borneo*, 1960) *C. t. toulou* (P. L. S. Müller) is found in Madagascar, *C. t. insularis* Ridgway is confined to Aldabra Is. and *C. t. assumptionis* confined to Assumption Is. The Bornean Coucals are the Common Coucal, *Centropus sinensis* (Stephens), the Lesser Coucal *C. bengalensis* (Gmelin) which is also common, and the rare Short-toed Coucal, *C. rectunguis* Strickland, a rare bird known from four specimens.

## MORPHOLOGICAL DESCRIPTIONS

### Family **ANOPLOCEPHALIDAE** Cholodkovsky, 1902

### Genus ***PARONIA*** Diamare, 1900

### ***Paronia bocki*** Schmelz, 1941

(Text-figs. 1–3)

HOST: *Megalaima chrysopogon* 8891*.

Only fragments of what appears to be one, incomplete worm are present and these total about 80 mm. in length. The maximum breadth is 2 mm. The proglottides are all broader than long with a tendency, in the more gravid proglottides, to become square.

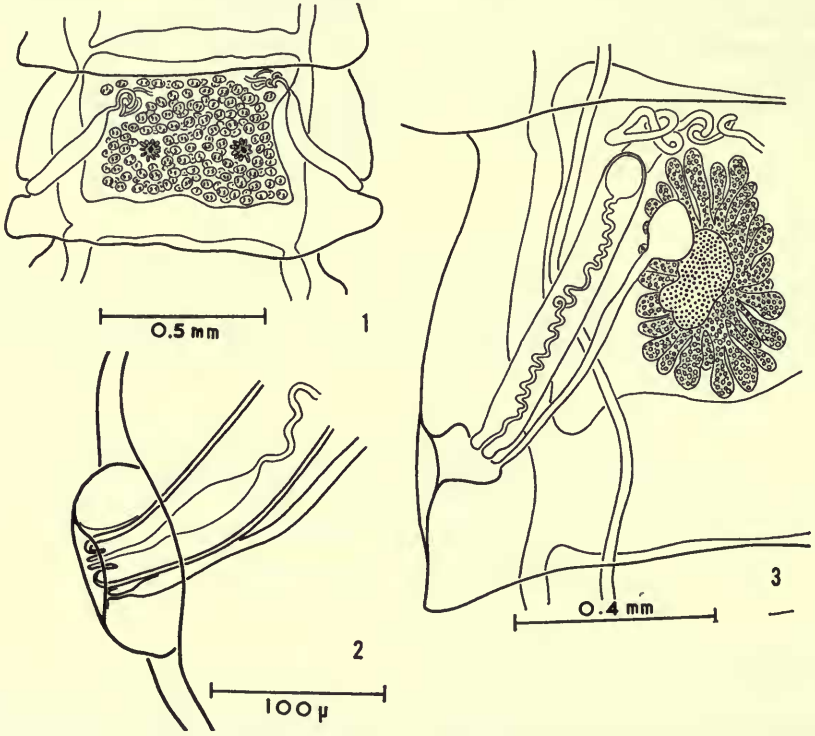
The scolex is missing.

The testes are numerous (Text-fig. 1) and develop before the ovaries. Over 150 testes were seen in one proglottis, but they are difficult to count accurately owing to the displacement of the genitalia by the unnaturally swollen excretory vessels. In some proglottides the testes attain a maximum diameter of about 70 $\mu$, but are generally smaller averaging about 55 $\mu$ in diameter. The cirrus-sac measures 400–600 $\mu$ in length, but may be longer as, in many instances, there are pronounced twists which tend to foreshorten it. The diameter of the cirrus-sac remains fairly constant at 40–55 $\mu$ and in some proglottides the cirrus can be seen protruding as a short nipple-like projection from the genital atrium (Text-fig. 2).

*Host name and number according to collection records.

The deeply-lobed ovaries are 380–520 $\mu$ by 200–240 $\mu$ and are fan-shaped, The vitelline glands, which measure 150–170 $\mu$ by 110–125 $\mu$, tend to be surrounded by the ovarian lobes (Text-fig. 3).

The uterus breaks down into uterine capsules, each of which contains a single egg. Although initially the two uteri are quite separate, the capsules eventually fill the whole proglottis. The outer membrane of the egg measures 50–60 $\mu$ by 38–48 $\mu$ and the inner membrane measures 28–34 $\mu$ in diameter. The hooks of the oncospheres were not seen sufficiently clearly to be measured.




FIGS. 1–3. *Paronia bocki* Schmelz, 1941. Early proglottis showing distribution of testes (Fig. 1), opening of cirrus-sac (Fig. 2), and part of a later proglottis showing one of the two ovaries and the associated vitelline gland (Fig. 3).

The excretory vessels appear to be unnaturally swollen and have the effect of crowding the genitalia into isolated regions in most proglottides. The transverse excretory vessel, which joins the two ventral excretory vessels posteriorly in each proglottis, is particularly prominent and swollen in fully-mature and gravid proglottides.

DISCUSSION. Schmelz (1941) differentiates his species from *Paronia carrinoi* Diamare, 1900, on the formation of the uterus in gravid proglottides. In *P. bocki*, the two uteri eventually join to form a continuous field of uterine capsules, whereas in *P. carrinoi* both uteri remain separate. This feature, together with the difference in the size of the cirrus-sac, also serves to differentiate *P. bocki* from *P. pycnonoti*

Yamaguti, 1935. Although the number of testes in the present material may be fewer than the number described by Schmelz, and although there is a slight discrepancy in the sizes of the ovaries (380–520 $\mu$ by 200–240 $\mu$ in the present material and 700 by 290 $\mu$ in Schmelz's material) in view of the close agreement of other characters, there seems little doubt that the present material should be ascribed to *P. bocki* Schmelz, 1941. Further differences between the known species of *Paronia* can be seen readily in Table I.

*P. carrinoi* is listed by Yamaguti (1959) as *P. carrinii* and is included as a synonym of *P. trichoglossi* (Linstow, 1888). As indicated by Spasski (1951), Linstow, in his original description, mentions that the material is fragmented, without a scolex, and gives only the length and breadth of the fragments, the sizes of some proglottides, and the size of the eggs and oncospheres. Furthermore, Linstow indicates that " The specimens possibly belong to *Taenia leptosoma*, Diesing, found in various parrots ", and this worm, *T. leptosoma*, is now considered as belonging to the genus *Raillietina*. It would appear then that the grounds for including Diamare's species as a synonym of such an inadequately-described worm, are not really sufficient, and it is here proposed that the specific name *carrinoi* be retained and that it should not become a synonym of *P.* (?) *trichoglossi*.

## Family **DAVAINEIDAE** Fuhrmann, 1907

## Genus ***RAILLIETINA*** Fuhrmann, 1920

### ***Raillietina* (*Raillietina*) *echinobothrida*** (Megnin, 1881)

(Text-figs. 4–8)

*Taenia bothrioplites* Piana, 1882.
*Davainea paraechinobothrida* Magalhães, 1898.
*Davainea volzi* Fuhrmann, 1905.
*Davainea penetrans* Baczynska, 1914.
*Raillietina grobbeni* Böhm, 1925.
*Raillietina pseudoechinobothrida* Meggitt, 1926

Host. Domestic fowl (*Gallus gallus* (L.) *dom.*) 8696.

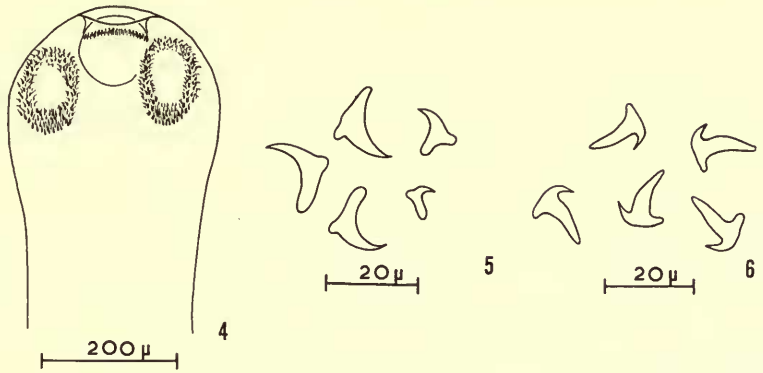
The longest specimen is 105 mm. long with a maximum breadth of about 3 mm. The proglottides are all much broader than long, the ratio of breadth to length tending to increase from immature to mature proglottides and tending to decrease from mature to gravid proglottides. The genital apertures are unilateral and are situated laterally and slightly posteriorly to the middle of each proglottis. The genital ducts pass between the dorsal and ventral excretory vessels.

The size of the scolex (Text-fig. 4) shows considerable variation, measuring 170–265 $\mu$ long by 240–330 $\mu$ broad. The four suckers are circular to oval in outline and measure 90–155 $\mu$ by 52–90 $\mu$. They are profusely armed with spines (Text-fig. 5) which are 9–17 $\mu$ long. The rostellum, when everted, is roughly spherical with a diameter of about 100 $\mu$. It is armed with a double circlet of about 200 hooks (Text-fig. 6) which are 12–14 $\mu$ long.

## Table I

*Paronia* species to show various differences and similarities to the present material from Borneo.

| Species | *Strobila* length in mm. | *Strobila* max. breadth in mm. | *Scolex* diameter in microns | *Cirrus Sac* length in microns | *Testes* No. | *Testes* Diameter in microns | *Gravid Uterus* | *Egg* diameter in microns | *Host* | *Locality* |
|---|---|---|---|---|---|---|---|---|---|---|
| *P. ambigua* (Fuhrmann, 1902) | 60–80 | 1·5 | — | 120 | 100 | 60 | single | 30 | *Amazona amazonica* RHAMPHASTIFORMES | Brazil |
| *P. beauforti* (Janicki, 1906) | 18 | 3 | — | 600 | 360 | — | single | — | *Cyclopsittacus diophthalmus* PSITTACIFORMES | New Guinea |
| *P. biuterina* Burt, 1939*a* | 55 | 2·25 | 265 | 215–272 | 65–75 | 38 | double | 27–30 | *Coryllinus beryllinus* PSITTACIFORMES | Ceylon |
| *P. bocki* Schmelz, 1941 | 70–75 | 5 | 800 | 700 | 200–220 | 77 | single | 40 | *Megalaema vireus; Cyanops ramsayi* PICIFORMES | Siam |
| *P. calcaruterina* Burt, 1939*a* | 126 | 2·1 | 690 | 380–420 | 102–120 | 85 | double | 31–32·5 | *Molpastes haemorrhous* PASSERIFORMES | Ceylon |
| *P. carrinoi* Diamare, 1900 | 70–120 | 3–5 | 530 | 450–700 | 140–150 | 45 × 10 | double | 30 | *Trichoglossus novaehollandiae; T. nigrigularis; Cyclopsittacus suavissimus; Lorius erythrothorax* PSITTACIFORMES | Australia; New Guinea |
| *P. columbae* (Fuhrmann, 1902) | — | 1 | — | 90 | 200 | — | single | 30 | *Columba* sp. (?); *Ptilonopus* sp. (?) COLUMBIFORMES | Sumatra; Bengal |
| *P. coryllidis* Burt, 1939*a* | 70–75 | 1·2 | 305–315 | 325 | 70–80 | 68 | single | 21–24 | *Coryllis beryllinus* PSITTACIFORMES | Ceylon |
| *P. pycnonoti* Yamaguti, 1935 | 40–55 | 2·5–3·2 | 480–580 | 250–400 | 80–125 | — | double | 42–48 | *Pycnonotus sinensis* PASSERIFORMES | Formosa |
| *Taenia trichoglossi* von Linstow, 1888 | over 80 | 2·1 | missing | — | — | — | — | 36 (outer) 26 (inner) | *Trichoglossus swainsoni* PSITTACIFORMES | Australia |
| *P. variabilis* (Fuhrmann, 1904) | 70 | 2·5 | 450 | 270 | 100 | 40 | single | 43 | *Rhamphastos culminatus; R. dicolorus; R. toco; R. erythrorhynchus.* PSITTACIFORMES | South America |
| *P. zavattarii* Fuhrmann and Baer, 1944 | — | 1·4–3·3 | — | 300 | — | — | double | 36–40 | *Colius striatus* COLIIFORMES | Ethiopia |
| Borneo material | over 80 | 2 | — | 400–600 | over 150 | 55–70 | single | 50–60 × 38–48 | *Megalaema chrysopogon* PASSERIFORMES | Borneo |

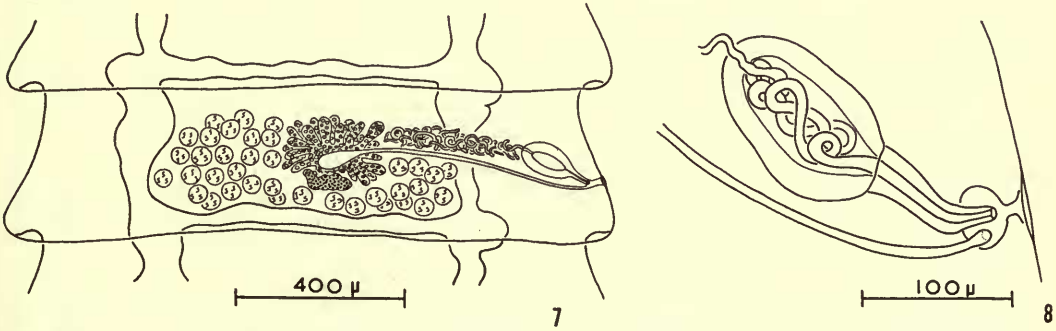



FIGS. 4–6. *Raillietina* (*Raillietina*) *echinobothrida* (Megnin, 1881). Scolex (Fig. 4), sucker spines (Fig. 5), and rostellar hooks (Fig. 6).

There are 20–45 testes which lie in two lateral fields (Text-fig. 7): those aporally comprise over half the total number. In many proglottides there are one, two or three testes which lie posteriorly or dorsally to the vitelline gland and which connect the two lateral fields.

The cirrus-sac (Text-fig. 8) measures 120–145 $\mu$ by 74–83 $\mu$ and opens into the genital atrium in the posterior half of each proglottis. It is bulbous and strongly muscled. The vas deferens is much coiled and lies in the anterior portion of each proglottis, in front of the ovary, and in fully-mature proglottides it becomes greatly distended with sperm.

The ovary which is fan-shaped and digitate lies in the middle of each proglottis. Its total breadth varies from 380 $\mu$ to 405 $\mu$. The vitelline gland, lying immediately behind the ovary, is compact and irregularly ovoid, measuring 120–140 $\mu$ by 70–80 $\mu$. Between the ovary and the vitelline gland lies the shell-gland which is dorsal to the receptaculum seminis. In only one proglottis could the receptaculum seminis be measured accurately, and there it measured 49 $\mu$ long by 38 $\mu$ in diameter. The vagina, in fully mature and early gravid proglottides, appears swollen with sperm in the region of the ovary.




FIGS. 7 and 8. *Raillietina* (*Raillietina*) *echinobothrida* (Megnin, 1881). Mature proglottis (Fig. 7) and cirrus-sac (Fig. 8).

The uterus is more or less sac-shaped initially, but later extends laterally beyond the excretory vessels and breaks down to form uterine capsules, which measure 110–170 $\mu$ in diameter. In over 85% of the capsules there are four or five eggs, but occasionally two, three or six eggs may be present in a capsule. The eggs are slightly ovoid and measure 42–52 $\mu$ by 32–42 $\mu$. The hooks of the oncosphere are 6–7 $\mu$ long.

Discussion. Although the group *echinobothrida* (Megnin, 1881) (*sensu lato*) shows considerable variation among its component species or subspecies, particularly with reference to the arrangement of genital apertures, number of testes and number of eggs per capsule (see Table II), these differences do not appear to be either sufficiently great nor, and perhaps of more importance, sufficiently constant to justify the separation of any distinct species other than *echinobothrida*.

Ransom (1904) discusses fully the problems of synonymity of *echinobothrida* up to that time and more recently Lang (1929) regards the following as synonyms of *echinobothrida* (Megnin, 1881): *Davainea volzi* Fuhrmann, 1905; *Davainea penetrans* Baczynska, 1914; *Raillietina* (*R.*) *grobbeni* Böhm, 1925; and *Raillietina pseudoechinobothrida* Meggitt, 1926. As can be seen from Table II there is a wide range of overlap in most characters, even as to the arrangement of the genital apertures. Megnin (1881), Ransom (1904), López-Neyra (1920) and Meggitt (1926) all describe material with irregularly-alternating genital apertures. Ransom, however, further states that they are sometimes almost entirely unilateral. López-Neyra (1920), discussing the synonymity of those species closely related to *echinobothrida*, is of the opinion that there are two distinct varieties: the one with irregularly alternating genital apertures, which contains Megnin's original species; and the other with unilateral genital apertures, which is the variety *bothrioplitis* and which includes *Davainea paraechinobothrida* Magalhães, 1898, *D. volzi* Fuhrmann, 1905, and *D. penetrans* Baczynska, 1914. López-Neyra, however, figures part of a strobila of *echinobothrida* var. *bothrioplitis* in which the genital apertures exhibit alternation. Although Meggitt (1926*a*), in his description of *echinobothrida* (Megnin, 1881) and of *pseudoechinobothrida*, states that the genital apertures are irregularly alternate, he modified this in a letter written to D. R. R. Burt and dated 27th August, 1936, when he said: " I have looked over my slides of *R. echinobothrida* and *R. pseudoechinobothrida*, and I find that the genital aperture is invariably unilateral. I think that the mis-understanding arises from the fact that an occasional genital pore is on the wrong side, but this is so seldom as not to count." It would thus appear that the variation in the arrangement of the genital apertures is of little real significance in this species, and that what was true of Meggitt's material was probably true of the other three instances. Accordingly, as the apertures, which appear on the " wrong " side, seem to be so few these probably constitute nothing more than exceptions to the general pattern of unilateral arrangement.

While discussing the problem of synonymity of *echinobothrida* with Professor J. G. Baer, he made the interesting observation that those species within the group *echinobothrida* (*sensu lato*) show a tendency to fall naturally into two separate, smaller groups: those from Europe; and those from Asia. In the case of those

species recorded from Europe there appear to be fewer testes and more eggs per capsule than in those species recorded from Asia. There is, nevertheless, some degree of overlap between these two conditions, and it probably would be unwise to do more at the present time than record this observation of differences, due apparently to geographical distribution.

It is clear that the whole question of synonymity of *echinobothrida* (*sensu lato*) will have to be gone into more fully and with more material from Asia particularly. Work is at present in hand on a large collection of cestodes from Ceylon, made by D. R. R. Burt, and it is hoped that the result of this investigation will throw more light on the above problems.

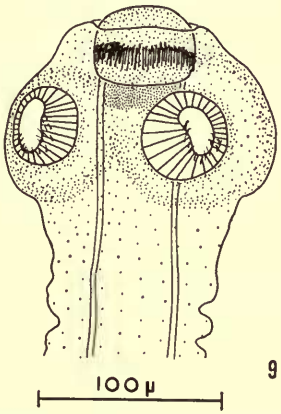
### ***Raillietina* (*Raillietina*) *johri*** Ortlepp, 1938

(Text-figs. 9–10)

*Raillietina* (*Raillietina*) *polychalix* of Johri, 1934, *nec* Kótlan, 1921.

Host. *Treron vernans* 8963; 9044; 9433; 9545.

The mature worms measure 50–70 mm. long by 0·6–1·0 mm. in maximum breadth. The proglottides are all broader than long, the breadth varying from two to five times the length depending upon the degree of contraction of the strobila. The genital apertures are unilateral and open in the anterior half of the margin of each proglottis. The genital ducts pass between the longitudinal excretory vessels.

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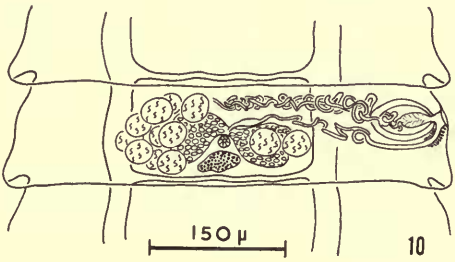


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Figs. 9 and 10. *Raillietina* (*R.*) *johri* Ortlepp, 1938. Scolex (Fig. 9) and mature proglottis (Fig. 10).

The scolex (Text-fig. 9) measures 90–130 $\mu$ by 60–150 $\mu$ and bears four armed suckers. The diameter of the suckers is 40–85 $\mu$ and the spines, which are up to 10 $\mu$ long, are easily lost and were not seen in all specimens. The rostellum, 60–68 $\mu$ in diameter, bears a double crown of hooks, those in the anterior row measuring 15 $\mu$ long and those in the posterior row measuring 12 $\mu$ long.

There are 6–12 testes usually divided into two groups which lie on either side of the female genitalia (Text-fig. 10). The poral group contains one to three testes while the majority lie aporally. The testes are ovoid to spherical and measure 50–70 $\mu$ by

## Table II

Species presently included in *Raillietina* (*Raillietina*) *echinobothrida* (*sensu lato*) to show the wide range in morphological characters.

| Species: | *echino-bothrida* | *botrio-plitis* | *paraechino-bothrida* | *echino-bothrida* | *volzi* | *penetrans* | *penetrans* |
|---|---|---|---|---|---|---|---|
| Described by: | Megnin 1881 | Piana 1881 | Magalhães 1898 | Ransom 1904 | Fuhrmann 1905 | Baczynska 1914 | Skrjabin 1914 |
| Strobila (length × max. breadth in mm.) | 50–100 × 4 | 200 × 3 | | 250 × 4 | 40–60 × 2 | 30–40 × 1–5 | 180 × 3 |
| Scolex (diameter in $\mu$) | — | 350 | | 250–450 | 450 | 352 | 374 |
| Rostellum (diameter in $\mu$) | — | 140 (from drawing) | | 100–150 | 88 | 104 | — |
| Rostellar hooks (number) | 100 | 200 | | 200 | 240 | 240 | 240–300 |
| Rostellar hooks (length in $\mu$) | 8 | 10–15 (from drawing) | | 10–13 | 10 | 13 | 13 |
| Suckers (diameter in $\mu$) | large | 120–130 (from drawing) | | 90–200 | 180 | 169 | — |
| Sucker spines (number of rows) | 7 | 7–8 | | 8–10 | Ant. = 12–14 Post. = 4–6 | 14–15 | — |
| Sucker spines (length in $\mu$) | — | 6–19 (from drawing) | | 6–15 | 6–12 | — | — |
| Testes (number) | — | — | | 20–30 | 30 | 15–20 | 30–35 |
| Testes (diameter in $\mu$) | — | — | | — | 30–36 | 41·6 | — |
| Cirrus sac (length in $\mu$) | — | — | | 130–180 | 200–230 | 163 | 163 |
| Eggs (number per capsule) | 6–7 | — | | 6–12 | 8–12 | — | — |
| Eggs (diameter in $\mu$) | 90 | — | | 25–50 | 20–25 | — | — |
| Oncospheres (diameter in $\mu$) | — | — | | — | 13 | 10·4 | — |
| Genital apertures (arrangement) | Irregularly alternating | Unilateral | | Irregularly alternating | Unilateral | Unilateral | Unilateral |

Differs from *echinobothrida* of Megnin only in the fact that it has unilaterial genital apertures.

| Species: | *echinobothrida* | *echinobothrida* var. *bothrioplitis* | *grobbeni* | *pseudoechinobothrida* | *echinobothrida* | *echinobothrida* | *echinobothrida* | *Borneo material* |
|---|---|---|---|---|---|---|---|---|
| Described by: | López-Neyra 1920 | López-Neyra 1920 | Böhm 1925 | Meggitt 1926*a* | Lang 1929 | Sawada 1955 | Yamaguti 1956 | |
| Strobila (length × max. breadth in mm.) | 150×4 | 230×4 | 170–440×4·1 | 80–90×1·8 | 35–200×3 | 120–250×4 | 60–160×2·4 | 105×3 |
| Scolex (diameter in $\mu$) | 250–450 | 250–450 | 344 | — | 286–343 | 250–550 | 250–400 | 170–265 |
| Rostellum (diameter in $\mu$) | 88–150 | 88–150 | 96 | — | 96–107 | 100–140 | 100–130 | 100 |
| Rostellar hooks (number) | 200–240 | 200–240 | 200 | 200 | 120–140 | 200 | — | 200 |
| Rostellar hooks (length) in $\mu$ | 10 & 13 | 10 & 13 | 10 & 13 | 8–12 | 10 & 13 | 10–13 | 10 & 12 | 12–14 |
| Suckers (diameter in $\mu$) | 90–200 | 90–200 | 125 | — | 120–140 | 130–200 | 210 | 52–115 |
| Sucker spines (number of rows) | 10–15 | 10–15 | — | — | 8–12 | 10–13 | 9–14 | Several |
| Sucker spines (length in $\mu$) | 6–15 | 6–15 | 7–17 | — | 5–15 | 4–20 | up to 12 | 9–17 |
| Testes (number) | 20–? | 20–35 | 24–32 | 30–50 | 25–45 | 25–45 | 38–48 | 20–45 |
| Testes (diameter in $\mu$) | 39–43 | 39–43 | 54 | — | 38–67 | — | 24–60 | 35–60 |
| Cirrus sac (length in $\mu$) | 130–200 | 130–190 | 182–187 | — | 150–200 | 150–165 | 120–190 | 120–145 |
| Eggs (number per capsule) | 8–12 | 8–12 | up to 6 | 3–4 | 4–10 | 3–8 | 5–9 | 2–6 |
| Eggs (diameter in $\mu$) | 25–40 | 25–40 | 24–37 | — | 34–48 | 73–77 | 27–42 | 32–52 |
| Oncospheres (diameter in $\mu$) | 10–14 | 10–14 | 10–15 | — | 10–18 | 24–26 | 10–15 | 12–18 |
| Genital apertures (arrangement) | Irregularly alternating | Unilateral | Unilateral | Irregularly alternating | Unilateral | Unilateral or Irregularly alternating | — | Unilateral |

36–60 $\mu$. The cirrus-sac, 85–115 $\mu$ long by 40–60 $\mu$ in diameter, is roughly flask-shaped and has a thick muscular wall. In a few proglottides the profusely armed cirrus could be seen as a small bulbous projection from the genital atrium. There is an internal seminal vesicle with a diameter of 15–30 $\mu$. The vas deferens is much coiled and lies parallel to the anterior margin of each proglottis.

The bilobed ovary lies in the centre of the proglottis and measures 115–135 $\mu$ across both lobes. The vitelline gland, situated posteriorly to the isthmus of the ovary, is compact and measures 45–75 $\mu$ by 30–55 $\mu$. The shell-gland, 20–25 $\mu$ in diameter, lies more or less centrally over the isthmus of the ovary, occasionally being slightly displaced so that it lies partly over one of the lobes of the ovary. The vagina expands before reaching the centre of the proglottis to form a receptaculum seminis, 25–45 $\mu$ long by 15–25 $\mu$ in diameter. The opening of the vagina is posterior to the opening of the cirrus-sac.

The uterus breaks down to form 18–30 capsules per proglottis and occasionally more, the size of the capsules varying from 50–80 $\mu$ in long diameter by 40–65 $\mu$ in short diameter. In some few capsules, which contained more than the normal number of eggs, the long diameter reached as much as 100 $\mu$ or more. There are 8–12 eggs per capsule usually, while some capsules contained as few as 6 and others as many as 16 eggs. The eggs measure 35–40 $\mu$ by 27–33 $\mu$ and the contained oncospheres are about 15 $\mu$ in diameter.

Discussion. *Raillietina* (*Raillietina*) *polychalix* Kótlan, 1921, was described by Johri (1934) from *Psittacula krameri manillensis* and from *Columba livia domestica*, although the worms from *Columba* differed quite markedly from those found in *Psittacula*. According to Johri, however, these differences are not sufficiently great to warrant separation of the worms and the erection of a new species, and accordingly the worms from both hosts were identified as *polychalix*. Ortlepp (1938), however, feels that the differences between the worms from *Columba* and those from *Psittacula* are too great to allow the inclusion of both groups of worms in the species *polychalix* and erects a new species, *Raillietina* (*Raillietina*) *johri*, to contain those worms which were found in *Columba livia domestica*. The two differences that Ortlepp considers to be most significant are the different sizes of the cirrus-sac and the different number of rostellar hooks (See Table III).

Table III

*Raillietina* (*Raillietina*) *polychalix* Kótlan, 1921, as described by Johri (1934).

| Host | Number of rostellar hooks | Length of cirrus sac |
|---|---|---|
| *Columba* | 324 | 125–130$\mu$ |
| *Psittacula* | 190 | 61$\mu$ |

Perhaps it should also be pointed out that the worms described by Johri that came from *Psittacula* show even less similarity to Kótlan's species *polychalix* than did the worms from *Columba*, and accordingly it would appear that neither of the worms which Johri described is in fact *polychalix* Kótlan. Proper identification of the worms from *Psittacula* will have to await a full re-examination of the material and comparison with known species.

The present material agrees well with the few characters that are given for *Raillietina* (*Raillietina*) *johri* and also seems to differ in one or more characters from all other species of *Raillietina* from birds, where the size of rostellar hooks is within the same range of 12–15 $\mu$, and where the number of testes also falls within the same range of 6–12 testes per proglottis (See Table IV). As can be seen, the only species with which the present material does not differ significantly, apart from *johri*, is *Raillietina* (*R.*) *circumcincta* (Krabbe, 1869) but this worm is very poorly described and furthermore comes from a well-separated order of birds, the Ciconiiformes.

According to the label in one of the tubes containing worms of the present species the host is *Tringa glareola*, a charadriiform bird, but as there does not appear to be any substantiated record of a *Raillietina* from any member of the Charadriiformes (see discussion following description of *Kowalewskiella susanae* n. sp.), it is not unlikely that there may have been a mix-up in the labels. All measurements of the present material from *Tringa glareola* are recorded separately, as follows, to facilitate comparison in the event of there being any further recorded *Raillietina* from a Charadriiform bird.

Strobila—41 × 1·15 mm.; scolex—165 × 210 $\mu$; rostellum—100 $\mu$ diam.; rostellar hooks—200–250 hooks, in double circle, about 12 $\mu$ long (size measured from whole mount); suckers—armed, 65–70 $\mu$ in diameter; genital apertures—unilateral; testes—6–11, 37–52 $\mu$ in diameter, on both sides of the female genitalia; cirrus-sac—95–130 $\mu$ by 50-75 $\mu$; internal seminal vesicle present; ovary–bilobed; vitelline gland—median, posterior to ovary, ovoid; receptaculum seminis—59 $\mu$ × 45 $\mu$; egg capsules—not extending beyond longitudinal excretory vessels, containing about seven eggs per capsule.

### ***Raillietina* (*Raillietina*) *parviuncinata*** Meggitt et Saw, 1924

(Text-figs. 11–13)

Host. Domestic fowl (*Gallus gallus* (L.) *dom.*) 8696.

The mature worm measures 35 mm. long by 0·9 mm. in maximum breadth. The proglottides are broader than long, but only immature and early mature ones are present. The genital apertures are unilateral and open in the anterior half of the margin of each proglottis.

The scolex (Text-fig. 11) measures 170 $\mu$ long by 240 $\mu$ in diameter and bears four, heavily armed suckers. The suckers are oval measuring 92–100 × 52–66 $\mu$ and the sucker spines, while being difficult to measure accurately, appear to reach up to 12 $\mu$ long. The rostellum is not evaginated and bears a complete double row of about 200 hooks which are 8–10 $\mu$ long.

In the early mature proglottides present, the testes number 20 to 30 and are 38–46 × 34–43 $\mu$. The cirrus-sac was not clearly seen, but appears to be about 70–80 $\mu$ long by about 40–50 $\mu$ in diameter.

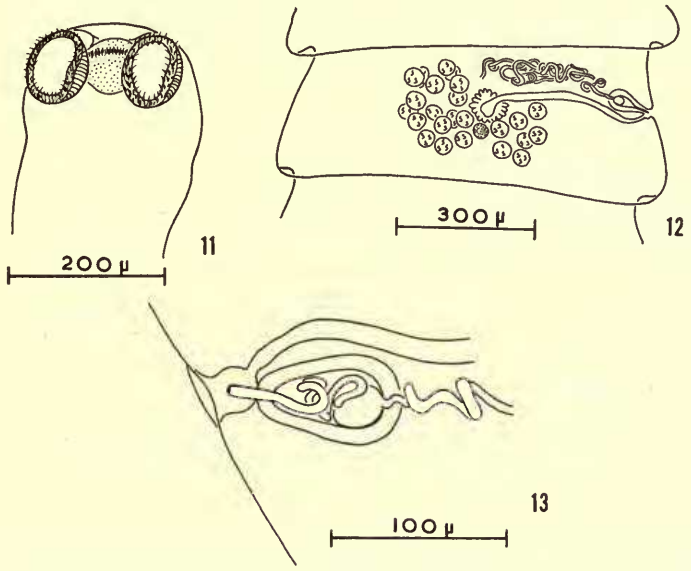
Discussion. Although there are several discrepancies between the present material and those worms described by Meggitt and Po Saw (1924), it is apparent

## Table IV

*Raillietina* (*Raillietina*) species from birds with rostellar hooks in the range 12–15$\mu$ long and with 6–12 testes.

| Species: | *circumcincta* | *micracantha* | *micracantha* | *provincialis* | *spiralis* | *bycanistis* | *polychalix* | *polychalix* | *johri* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Krabbe, 1869 | Fuhrmann, 1909 | Fuhrmann, 1909 | Linstow, 1909 | Baczynska, 1914 | Baylis, 1919 | Kótlan, 1921 | Kótlan, 1921 | Ortlepp, 1938 | Borneo material |
| Description taken from: | Krabbe 1869 | Fuhrmann 1909 | López-Neyra 1931 | Linstow 1909 | Baczynska 1914 | Baylis 1919 | Kótlan 1921 | Johri 1934 | Ortlepp 1938 | |
| Strobila (length × max. breadth in mm.) | 120 × 2 | 100 × 0·8 | 180 × 1·2 | 60 × 1·58 | 30–40 × 1·28 | 140 × 2 | 55 × 1·7 | 103 | 273 × 0·75 | 50–70 × 1 |
| Scolex (diameter in $\mu$) | — | 180 | 180–200 | 280 | 224 | 270 | 320 | — | 260 | 90–130 |
| Rostellum (diameter in $\mu$) | — | — | 117–135 | — | 150 | 150 | 148 | — | — | 60–68 |
| Rostellar hooks (number) | 300 | 200 | 150 | 500 | 300 | — | 240–250 | 190 | 324 | |
| Rostellar hooks (length in $\mu$) | 11–12 | 13–14 | 12–14·7 | 14·3 | 15·6 | 15 | 13 | 13·5 & 19 | 11 & 14 | 12 & 15 |
| Suckers (diameter in $\mu$) | — | — | 50–65 × 40–50 | 130 | 52 | 88 | — | — | — | 40–85 |
| Sucker spines (length in $\mu$) | — | — | 9–10 | — | — | 13 | — | — | 6–7 | 10 |
| Testes (number) | — | — | 14–18 | 10–12 | 6–7 (by implication) | 12–14 | 10–12 | 9–11 | 8–9 | 6–12 |
| Testes (diameter in $\mu$) | — | — | 50 × 45 | 57–68 | 39 | 75 | 40 | — | — | 50–70 × 36–60 |
| Cirrus sac (length × diameter in $\mu$) | — | — | 110–140 × 40–60 | — | 101 | 200 × 62 | 120 | 61 | 125–130 | 85–115 × 40–60 |
| Eggs (number per capsule) | — | — | 4–7 | several | 4–6 | 4–5 | 2–5 | — | 6 | 8–12 (6–16) |
| Eggs (diameter in $\mu$) | — | — | 38–42 × 35–40 | 52 | — | — | — | — | — | 35–40 × 27–33 |
| Oncospheres (diameter in $\mu$) | — | — | 14–15 | 18 | — | 15 | — | — | — | 15 |
| Avian host (order) | Ciconii-formes | Columbi-formes | Columbi-formes | Galli-formes | Columbi-formes | Coracii-formes | Psittaci-formes | Psittaci-formes | Columbi-formes | Columbi-formes |

that in their description there are several typographical errors. The maximum breadth of the worm, for instance, is quoted as being 0·2 mm. and yet in the text-figure on page 325 a mature proglottis is drawn which, according to the scale given, measures over 1·0 mm. in breadth. The cirrus-sac in their description is described as being 0·58 to 0·84 mm. in length, whereas it is again clear from the drawing on page 325 that the length should be 0·058 to 0·084 mm.




FIGS. 11–13. *Raillietina* (*R.*) *parviuncinata* Meggitt et Saw, 1924. Scolex (Fig. 11), mature proglottis (Fig. 12), and cirrus-sac (Fig. 13).

In view of the close agreement between the length of rostellar hooks (7–9 μ—Meggitt and Po Saw; 8–10 μ—present material); the number of testes (24–39—Meggitt and Po Saw; 20–30—present material); and the length of the cirrus-sac (58–84 μ—Meggitt and Po Saw; 70–80 μ—present material) the present material is tentatively identified as *Raillietina parviuncinata*. This identification should remain tentative owing to the fact that *parviuncinata* was recorded initially from an anseriform bird, whereas the present material comes from a galliform bird. So far as can be ascertained, however, the present worms do not resemble any known species from a galliform bird well enough to warrant identification with them.

### ***Raillietina* (*Raillietina*) *sequens*** Tubangui et Masiluñgan, 1937

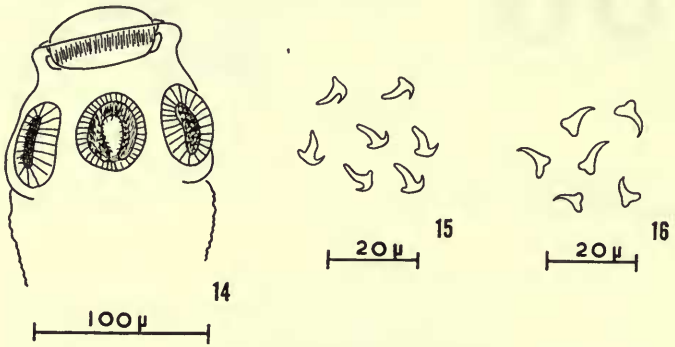
(Text-figs. 14–18)

HOSTS. Domestic pigeon (*Columba livia* domestica L.) 9019. *Streptopelia chinensis* 9409, 9151. *Aegithina tiphia* 9047.

The largest worm measures 100 mm. in length and the maximum breadth is 1·5 mm. The proglottides are all broader than long, with the ratio of breadth

to length generally increasing towards the posterior end of the worm. The genital apertures are unilateral and the genital ducts pass between the excretory vessels.

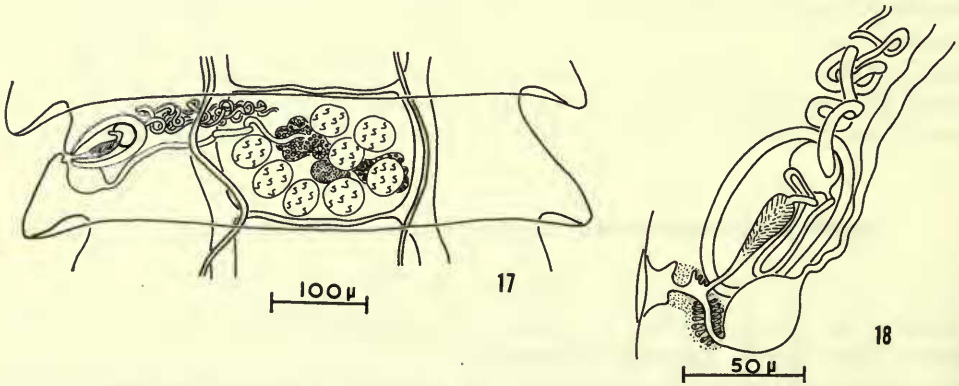
The scolex (Text-fig. 14) varies in diameter from 80 to 122 $\mu$ and bears a rostellum which measures 45–90 $\mu$ (everted and withdrawn) in diameter by 30–53 $\mu$ long. The rostellar hooks (Text-fig. 15) are arranged in two separate rows; those of the anterior row being slightly larger, measuring 7·5–8 $\mu$ in length while those of the posterior row measure only 6–7 $\mu$ in length. The four suckers measure 30–51 $\mu$ × 20–45 $\mu$ and are armed with spines (Text-fig. 16) which are 2–10 $\mu$ long.




FIGS. 14–16. *Raillietina* (*R.*) *sequens* Tubangui et Masiluñgan, 1937. Scolex (Fig. 14), rostellar hooks (Fig. 15), and sucker spines (Fig. 16).

There are 6–10 testes (Text-fig. 17) one to three usually lying porally, which measure 45–60 $\mu$ × 40–55 $\mu$. The cirrus-sac (Text-fig. 18) is 80–115 $\mu$ long × 40–60 $\mu$ in diameter and contains a slightly coiled cirrus, which is armed with hair-like, cuticular spines, and an internal seminal vesicle of 35–40 $\mu$ by about 30 $\mu$. The vas deferens becomes greatly swollen with sperm and highly twisted.

The ovary is bilobed with each of the two lobes tending to subdivide further into smaller lobules. It is situated medially and ventrally being contained within the confines of the ventral excretory vessels. The vitelline gland, lying immediately




FIGS. 17 and 18. *Raillietina* (*R.*) *sequens* Tubangui et Masiluñgan, 1937. Mature proglottis (dorsal view) (Fig. 17) and cirrus-sac (ventral view) (Fig. 18).

posteriorly to the ovary, is irregularly ovoid and measures 30–40 $\mu$ in diameter. Immediately in front of the vitelline gland, but posterior to the ovary, is the shell-gland of 20–25 $\mu$ in diameter. The receptaculum seminis is just posterior to the cirrus-sac and tends, in many cases, to lie slightly ventrally to it. It is highly variable in size, measuring up to 50 $\mu$ × 25 $\mu$.

The uterus, which arises immediately dorsally to the shell-gland, is initially a sac-like structure, but eventually occupies the whole of the medulla before breaking down into uterine capsules. The number of capsules per proglottis is variable, but generally falls between 50–70, each capsule measuring 50–100 $\mu$ × 35–55 $\mu$. There are 2–8 oncospheres per capsule and these measure 25–40 $\mu$ × 15–35 $\mu$. The hooks of the oncospheres are small, ranging from 5·5 $\mu$ to about 7 $\mu$ in length.

Discussion. As can be seen in Table V there are several worms which have only a few testes and which also possess small rostellar hooks. In many instances the only difference between separate species is that one species may have one or two testes more, or fewer, than another. This hardly seems to be a justifiable criterion for the erection of new species, as it is abundantly clear in the present material that the range in number of testes is fairly wide. However, it should be noted that this range of 6–10 testes has not been seen in any single worm, but represents the total range in all the worms which otherwise are more or less identical from the different hosts mentioned. Thus, some individual worms show a range of 6–7 testes; others a range of 6–8; others a range of 8–10 and so on. While this observation could be interpreted as indicating that there are two or more separate species present, in view of the extremely close similarity of other features, and the fact that there is no other constant difference manifest between worms showing differences in number of testes, it is here proposed that the range of 6–10 testes represents an intraspecific variation in the species *R. sequens*. Furthermore a re-examination of the species listed in Table V, and also many other species in the genus *Raillietina*, may very well show that the intraspecific variation is so great that several species which at present are considered as distinct should in fact be united into a single species. In view of the fact that it has not been possible, as yet, to see sufficient type-material, redescriptions from the suggested re-examination will not be presented at this time.

Except in the number of testes, as has just been discussed, the present material appears to agree in all respects with worms described by Tubangui and Masiluñgan (1937) as *Raillietina* (*R.*) *sequens* and is, accordingly, here identified as that species.

### ***Raillietina* (*Raillietina*) *allomyodes*** Kótlan, 1921

(Text-fig. 19)

Host. *Treron vernans* 8951.

One mature, but non-gravid, worm was present. It measures 15 mm. long and has a maximum breadth of 0·8 mm. The worm is highly contracted and accordingly the shape of the proglottides, which ranges from 24 times broader than long in immature proglottides to 11 times broader than long in the last mature proglottides, is of little significance. The genital apertures are unilateral.

## Table V

*Raillietina* species possessing rostellar hooks under 10 $\mu$ long and with 5–10 testes.

| Species: | *cryptacantha* Fuhr., 1909 | *paucitesticulata* Fuhr., 1909 | *cacatuina* Johnst., 1911–13 | *calyptomenae* Baylis, 1926 | *flabralis* Meggitt, 1927 | *flaminiata* Meggitt, 1931 | *fragilis* Meggitt, 1931 | *fulvia* Meggitt, 1933 | *sequens* Tub. & Mas., 1937 | Borneo material |
|---|---|---|---|---|---|---|---|---|---|---|
| Descriptions taken from: | Fuhrmann (1909) | Fuhrmann (1909) | López-Neyra (1931) | Baylis (1926) | Meggitt (1927*a*) | Meggitt (1931) | Meggitt (1931) | Meggitt (1933) | Tubangui & Masiluñgan (1937) | |
| Strobila (length × max. breadth in mm.) | 120 × 1·5 | 100 × 0·6 | 50 × 0·53 | 60–100 × 1·15 | 350 × 1 | 50 × 0·6 | 190 × 0·9 | ? × 6·0 | 170 × 1·1 | 100 × 1·5 |
| Scolex (diameter in $\mu$) | 140 | 100 | 114 | 170–250 | 216 | 720 | 150 | 110–120 | 100 | 80–122 |
| Rostellum (diameter in $\mu$) | 59 | 44 | — | 100–125 | 80 | — | 73 | 35–40 | 60 | 45–90 |
| Rostellar hooks (number) | 170 | 120 | — | Very numerous | 350 | — | — | — | 180 | — |
| Rostellar hooks (length in $\mu$) | 7·2 | 9–10 | Ca. 6 | 8 | 6 | 9 | 6–9 | — | 7·6–8 | 6–8 |
| Suckers (diameter in $\mu$) | 36 | 27 | 45 | 55–80 | — | — | — | — | 40 | 30–51 × 20–45 |
| Sucker spines (number of rows) | — | — | Several | — | — | — | several | several | — | several |
| Sucker spines (length in $\mu$) | — | — | 7·5 | minute | — | — | — | — | — | 2–10 |
| Testes (number) | 8–12 | 6–7 | 4–5 | 5 | 4–5 | 5–9 | 8–9 | 8–10 | 5–6 | 6–10 |
| Testes (diameter in $\mu$) | 68 | — | 20 | — | — | — | — | — | 55–70 | 40–60 |
| Cirrus sac (length × diameter in $\mu$) | — | 120–140 | 65–100 × 20–42 | 160 × 55 | up to 120 | 110–130 × 40–60 | 120 × 60 | 92–106 × 54–64 | 100–120 × 40–60 | 80–115 × 40–60 |
| Eggs (number per capsule) | — | 6–8 | 12 | 8 | 10 | 2–6 | 4–6 | 1 | 2–8 | 2–8 |
| Eggs (diameter in $\mu$) | — | — | 45 × 19 | — | — | — | — | — | 34·5–46 | — |
| Oncospheres (diameter in $\mu$) | — | — | — | — | — | — | — | 35–40 | 19–23 | 25–40 × 15–35 |
| Genital apertures (arrangement) | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral |
| Avian host (order) | Columbiformes | Columbiformes | Psittaciformes | Passeriformes | Coraciiformes | Columbiformes | Columbiformes | Columbiformes | Columbiformes | Columbiformes |

The scolex (Text-fig. 19) measures 200 $\mu$ long by 270 $\mu$ in diameter and bears a rostellum of 150 $\mu$ in diameter. The rostellar hooks, which number about 210, are present in a double circlet around the rostellum and are of two distinct sizes: those of the anterior row measuring 18 $\mu$ in length and those of the posterior row measuring 21 $\mu$ in length. The four suckers are ovoid, measuring 75–85 $\mu$ × 68–77 $\mu$, and are armed with three or four rows of thorn-shaped spines which vary from 5 $\mu$ to 10 $\mu$ long.

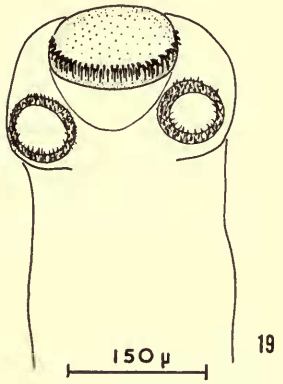



Fig. 19. *Raillietina* (*R.*) *allomyodes* Kótlan, 1921. Scolex.

There are 7–9 testes in each proglottis and in mature proglottides these are 30–50 $\mu$ in diameter. The cirrus-sac, which opens laterally in the anterior half of each proglottis, is 100–130 $\mu$ long by about 60 $\mu$ in diameter and contains a cirrus armed with long fine hairs. There is an internal seminal vesicle at the base of the cirrus-sac and this measure 20–25 $\mu$ in diameter. Leading into the seminal vesicle is a highly convoluted vas deferens which runs parallel to the anterior margin of each proglottis.

The ovary is bilobed and is situated centrally in a ventral position. The vitelline gland, which lies immediately posteriorly to the isthmus of the ovary, measures 20–35 $\mu$ × 90–105 $\mu$. There is a distinct swelling of the vagina, adjacent to the genital aperture, which measures 35–45 $\mu$ × 20–25 $\mu$ and which probably functions as a receptaculum seminis.

Discussion. Table VI lists those species of *Raillietina* which possess rostellar hooks in the range 18–21 $\mu$, and which possess less than 20 testes. As is suggested in the discussion following the description of *Raillietina* (*R.*) *sequens*, it seems probable that several of the different species listed may well be intraspecific varieties of a single species. For instance, the only real difference between *allomyodes* and *columbiella* lies in the lengths of the cirrus-sacs which are 120–150 $\mu$ and 160–230 $\mu$ respectively. Without a thorough re-examination of the type-material, it is not possible to state that these names are synonymous, but it could well be the case that the cirrus-sacs in *allomyodes* were measured in younger proglottides or, more probably, that the smaller size may be explained in terms of a difference in host-species. Similarly, it is quite clear from Table VI that *taiwanensis* and *weissi* are similar in most respects, differing only in that the former has 14–17 testes while

## Table VI

*Raillietina* species with less than 20 testes and with rostellar hooks in the range 18–21 $\mu$

| Species: | *filiformis* Vigueras, 1960 | *oligocantha* Fuhrmann, 1909 | *allomyodes* Kótlan, 1921 | *aruensis* Fuhrmann, 1911 | *columbiella* Ortlepp, 1938 | *flaccida* Meggitt, 1926 | *frayi* Joyeux & Houdemer, 1927 | *lutzi* Parona, 1901 |
|---|---|---|---|---|---|---|---|---|
| Description taken from: | Sawada (1964) | Fuhrmann (1909) | Kótlan (1921) | Fuhrmann (1911) | Ortlepp (1938) | Meggitt (1926*b*) | Joyeux & Houdemer (1927) | Parona (1901) |
| Strobila (length × max. breadth in mm.) | 54 × 0·4 | 50–80 × 1 | 60 × 0·76 | 100 × 2 | 34–67 × 2 | 130–150 × 1·2 | 71 × 1·5 | 52–60 × 1 |
| Scolex (diameter in $\mu$) | — | 370 | 289 | 300–38 (=380?) | 188–270 | — | 310–350 | 250 |
| Rostellum (diameter in $\mu$) | — | 110 | — | 110 | 120–180 | — | 140 | — |
| Rostellar hooks (number) | 90–100 | 34 | 160–200 | 180–200 | 200 | 150 | 350 | — |
| Rostellar hooks (length in $\mu$) | 20–21 | 21–23 | 17–18 | 18 | 19–22 & 16–18 | 17 & 22 | 16–18 | 20 |
| Suckers (diameter in $\mu$) | — | 180 | 78 | 90–100 | 58–80 × 70–90 | — | 70–90 | — |
| Sucker spines (length in $\mu$) | — | — | — | — | up to 10 | — | 12–15 | — |
| Testes (number) | 10–12 | — | 12–16 | 20 | 11–13 | 14–17 | 13 | — |
| Testes (diameter in $\mu$) | — | — | 40 | 50–60 | 63–77 | — | 30–45 | — |
| Cirrus sac (length × diameter in $\mu$) | — | 160 × ? | 120–150 × ? | 150 × ? | 160–230 × 50–87 | 100 × ? | 175 × 50 | — |
| Eggs (number/capsule) | 1 | 1 | 6–7 | — | 4–8 | 8–9 | 12 | — |
| Eggs (diameter in $\mu$) | — | 40–48 | — | — | — | — | — | — |
| Oncospheres (diameter in $\mu$) | — | 36 | — | — | — | — | 12 | — |
| Genital apertures (arrangement) | Unilateral | Irregularly alternating | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral |
| Avian host (order) | Columbiformes | Crypturiformes | Columbiformes | Psittaciformes | Columbiformes | Columbiformes | Columbiformes | Piciformes |

| Species: | *lutzi* Parona, 1901 | *nagpurensis* Moghe, 1925 | *penetrans nova* Johri, 1934 | *permista* Southwell & Lake, 1939 | *polychalix* Johri, 1934 (in part.) *nec* Kótlan, 1921 | *taiwanensis* Yamaguti, 1935 | *weissi* Joyeux, 1923 | *weissi* var. *valliclusa* Joyeux & Baer, 1936 | Borneo material |
|---|---|---|---|---|---|---|---|---|---|
| Description taken from: | Fuhrmann (1909) | López-Neyra (1931) | Johri (1934) | Southwell & Lake (1939) | Johri (1934) | Yamaguti (1935) | Joyeux (1923) | Sawada (1965) | |
| Strobila (length × max. breadth in mm.) | 60 × 1 | 250–274 × 1·9 | 248 × 0·67 | 30 × 1·5 | — | 170 × 1·8 | 142 × 2 | 140–150 × 2 | 15 × 0·8 |
| Scolex (diameter in $\mu$) | 470 | 339–382 | 250 | 240 | 103 | 240–280 | 150–170 (& up to 260) | 150–170 | 270 |
| Rostellum (diameter in $\mu$) | 70 | 216–241 | — | — | — | 150–180 | 100 | 100–150 | 150 |
| Rostellar hooks (number) | 100 | 220 | 154–184 | 36 | 190 | 200 | 150–300 | 200–250 | 210 |
| Rostellar hooks (length in $\mu$) | 18–19 | 17–19 | 14 & 19 | 18 | 13·5–19 | 19 | 16 & 19 | 20–25 | 18 & 21 |
| Suckers (diameter in $\mu$) | 110 | 142 × 114 | — | 136 | — | 60–84 | 44–60 | 40–60 | 75–85 × 68–77 |
| Sucker spines (length in $\mu$) | — | 7 | — | — | — | 8–10 | 10 | 10 | 5–10 |
| Testes (number) | — | 19–22 | 16–19 | 15–20 | 9–11 | 14–17 | 12 | 12–15 | 7–9 |
| Testes (diameter in $\mu$) | — | 72–78 | — | — | — | — | 60–80 | — | 30–50 |
| Cirrus sac (length × diameter in $\mu$) | — | 90–111 × 30–42 | 125–134 × ? | ca. 105 (from drawing) | 6 × ? | 100–120 × 28–42 | 100–130 × 25–40 | 100–130 × 25–40 | 100–130 × 60 |
| Eggs (number/capsule) | 12–16 | 3–8 | 5–7 | 6 | — | 3–8 | 6 | 6 | — |
| Eggs (diameter in $\mu$) | — | 50 × 43 | — | — | — | 36–42 | 33–43 | 43 | — |
| Oncospheres (diameter in $\mu$) | — | 17 × 14 | 47–55 | — | — | — | 18 | 18 | — |
| Genital apertures (arrangement) | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral |
| Avian host (order) | Piciformes | Columbi-formes | Passeri-formes | Piciformes | Psittaci-formes | Columbi-formes | Columbi-formes | Columbi-formes | Columbi-formes |

the latter possesses only 12 testes. Looking at the variety *weissi valliclusa*, however, it is clear that the range quoted for this variety, of 12–15 testes, falls exactly between the ranges for the two species just mentioned. Furthermore, in view of the evidence presented in the discussion on *Raillietina* (*R.*) *sequens* it would appear that the number of testes can show a relatively wide range within a single species and accordingly not only would *taiwanensis* and *weissi* be synonymous, but, further, these would simply represent variations of Kótlan's species, *allomyodes*. Although it is not intended that these, or any others, be united into a single species at the present time, the possibility that a difference in host-species may affect differently the morphological development of the infesting worms is obviously a strong possibility which warrants experimental verification.

The present material differs in at least one respect from all the other species described, but in view of the close similarity of *allomyodes*, *taiwanensis* and *weissi* to each other and to the present worms, these are identified as belonging to that group all members of which should, on grounds of priority, be referred to the species *allomyodes*.

### ***Raillietina* (*Raillietina*) sp.

Host. *Treron curvirostra* 9265.

The strobila measures 50 mm. long by 1·15 mm. in maximum breadth. Nearly all the segments are much broader than long although the last few segments have a tendency to become square or slightly longer than broad. The genital apertures are unilateral and situated in the anterior half of each proglottis.

The scolex is missing.

There are 20–24 testes which measure 45–60 $\mu$ × 23–37 $\mu$ and which are situated in two groups on either side of the female genitalia. The group on the aporal side contains more than that on the poral side. The cirrus-sac is long and unusually thin, measuring 110–125 $\mu$ long by only 15–25 $\mu$ in diameter. No seminal vesicle was seen and in none of the proglottides was the cirrus extruded. The vas deferens lies in large loose coils in the anterior, poral moiety of each proglottis.

The ovary is bilobed, each of the two lobes being digitate, and is situated centrally in the proglottis. The vitelline gland, 37–45 $\mu$ × 15–23 $\mu$, is compact and irregularly lobed, lying immediately behind the ovary.

The uterus breaks down to form about 25 capsules per proglottis which measure 115–150 $\mu$ × 85–100 $\mu$. In each capsule there are 6–9 eggs which measure 28–32 $\mu$ × 20–25 $\mu$, while the contained oncospheres are about 14 $\mu$ in diameter.

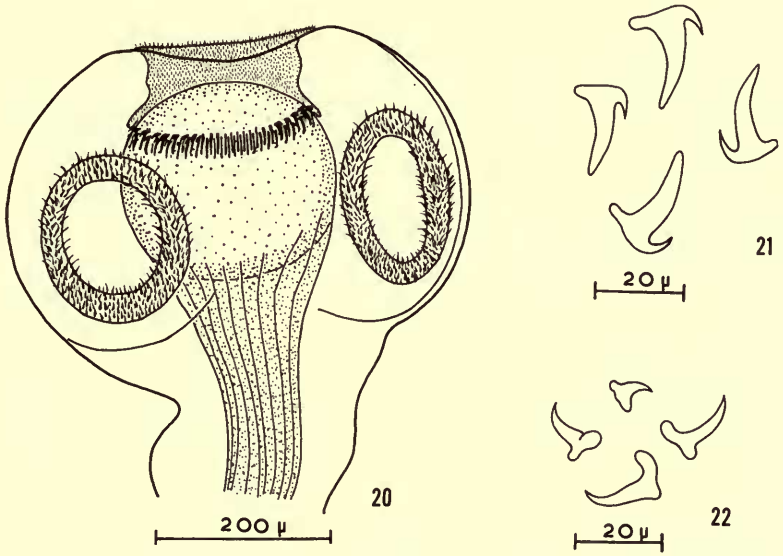
Discussion. Table VII contains those species of *Raillietina* (*Raillietina*) which: (a) parasitize birds; (b) possess a number of testes which falls in the range 20–24; and (c) possess a cirrus-sac the length of which falls in the range 100–150 $\mu$. As can be seen from the table, the present material agrees reasonably well with several species, but does not agree in every respect with any single species. However, in view of the fact that the scolex is missing and in view of the reasonable similarity to several other species this worm has neither been given the status of a new species, nor has it been identified with any existing species.

## *Raillietina* (*Paroniella*) *siamensis* Schmelz, 1941

(Text-figs. 20–24)

Hosts. *Megalaema chrysopogon* 8750, 8891, 9418; *Meiglyptes tukki* 9274; *Charadrius leschenaultii* 9486.

The longest specimen is 35 mm. and the maximum breadth from any of the worms is 1·15 mm. The proglottides are all broader than long and in mature proglottides the breadth varies from two to four times the length. The genital apertures are unilateral and the genital ducts pass between the dorsal and ventral excretory canals.




Figs. 20–22. *Raillietina* (*Paroniella*) *siamensis* Schmelz, 1941. Scolex (Fig. 20), rostellar hooks (Fig. 21), and sucker spines (Fig. 22).

The scolex (Text-fig. 20) measures 490–525 $\mu$ across the region of the suckers and has a length of about 350 $\mu$. The rostellum is 174–215 $\mu$ in diameter by 140–178 $\mu$ in length and bears a double crown of about 200–300 hammer-shaped hooks (Text-fig. 21). The hooks in the anterior row are larger than those of the posterior row; the former being about 28 $\mu$ long while the latter are only 19–23 $\mu$ long. There are four well-developed suckers, armed with spines (Text-fig. 22) of 8–18 $\mu$ in length. In some specimens the anterior part of the scolex could be seen to be covered with hair-like spines less than 3 $\mu$ long. This was easily seen where the rostellum was invaginated.

There are 20–40 testes (Text-fig. 23) which lie in two separate fields; the larger group lying aporally comprising 12–30 testes. The testes measure 40–90 $\mu$ × 37–68 $\mu$. The cirrus-sac has a length of 90–130 $\mu$ and a maximum diameter of 60–74 $\mu$. It has a thick wall of about 8 $\mu$ and opens into the genital atrium anteriorly to the opening of the vagina in the anterior half of the lateral margin. There is neither

## Table VII

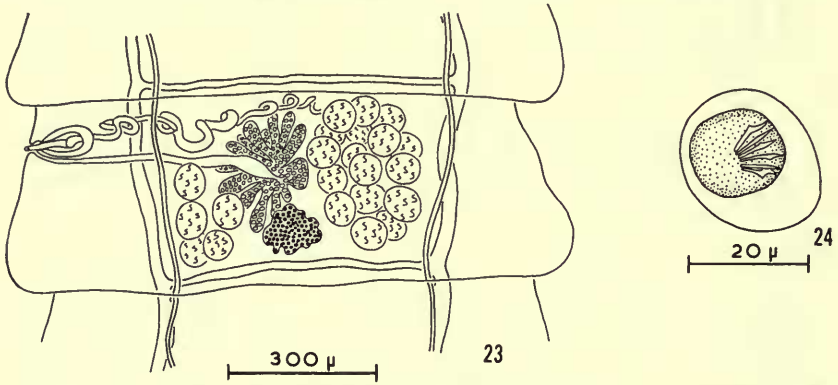
*Raillietina* (*Raillietina*) species with testes in the range 20–24 and with cirrus sacs in the range 100–150$\mu$ in length

| Species: | *aruensis* Fuhrmann, 1911 | *debilis* Baylis, 1919 | *goura* Fuhrmann, 1909 | *grobbeni* Böhm, 1925 | *kantipura* Sharma, 1943 | *korkei* Joyeux & Houdemer, 1927 | *leiopoae* Johnst. & Clark, 1948 |
|---|---|---|---|---|---|---|---|
| Description taken from: | Fuhrmann (1911) | Baylis (1919) | Fuhrmann (1909) | Böhm (1925) | Sharma (1943) | Joyeux & Houdemer (1937) | Sawada (1965) |
| Strobila (length × max. breadth in mm.) | 100×2 | 45×3 | 170×1·1 | 170–440 | 160–180×0·85 | 164×2 | 3–6 |
| Scolex (diameter in $\mu$) | 300–38 (=380)? | 200 | 180–200 | 344 | 220 | 200 | 650 |
| Rostellum (diameter in $\mu$) | 110 | 80 | 100 | 96 | 120 | 120–130 | 240–280 |
| Rostellar hooks (number) | 180–200 | enormous number | 300 | 100–200 | 180–200 | 150–160 | 133–154 |
| Rostellar hooks (length in $\mu$) | 18 | 8 | 9 | 13 & 10 | 20–22 | 18–20 | 39–52 |
| Suckers (diameter in $\mu$) | 90–100 | — | 50 | 125×95 | 55 | 60–70 | 160 |
| Sucker spines (length in $\mu$) | — | 12 | — | 7–17 | 4 | up to 10$\mu$ | 6–8 |
| Testes (number) | 20 | at least 30 | 18–20 | 24–32 | 16–26 | at least 24 | 22–23 |
| Testes (diameter in $\mu$) | 50–60 | — | 60 | 54 | — | 35 | — |
| Cirrus sac (length × diameter in $\mu$) | 150 | 125×60 | 120–140 | 112–117× 79–84 | 110 × 48 | 105–110×50 | 100–130× 60–70 |
| Eggs (number/capsule) | — | 4–5 | 8–10 | up to 6 | 3–6 | 6–9 | 21–26 |
| Eggs (diameter in $\mu$) | — | — | — | — | — | 18×14 | — |
| Oncospheres (diameter in $\mu$) | — | 15 | — | — | — | — | 11–14 |
| Genital apertures (arrangement) | Unilateral | ? | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral |
| Avian host (order) | Psittaciformes | Ciconiiformes | Columbiformes | Galliformes | Columbiformes | Columbiformes | Galliformes |

| Species: | *macroscolecina* Fuhrmann, 1909 | *michaelseni* Baer, 1925 | *nagpurensis* Moghe, 1925 | *nripendra* Sharma, 1943 | *permista* Southwell & Lake, 1939 | *pintneri* Klaptocz, 1906 | *werneri* Klaptocz, 1908 | Borneo material |
|---|---|---|---|---|---|---|---|---|
| Description taken from: | Fuhrmann (1909) | Baer (1925) | Moghe (1925) | Sharma (1943) | Southwell & Lake (1939) | López-Neyra (1931) | Klaptocz (1908) | |
| Strobila (length × max. breadth in mm.) | 60–80 × 1 | 55–60 × 0·82 | 250–274 × 1·9 | 200–250 × 1·25 | 30 × 1·5 | 35–72 × 1·4 | 55 | 50 × 1·15 |
| Scolex (diameter in $\mu$) | 380–430 | 420 | 339–382 | 187 | 240 | 219 | 200 | Scolex missing |
| Rostellum (diameter in $\mu$) | 200 | — | 216–241 | 110 | — | 42 | 75 | |
| Rostellar hooks (number) | 350 | 200–240 | 220 | 150–180 | 36 | 200 | 200 | |
| Rostellar hooks (length in $\mu$) | — | 12·8–13 | 19 & 17 | 12 | 18 | 6·4–8 | — | |
| Suckers (diameter in $\mu$) | — | 76 | 142 × 114 | 62 | 136 | 100 | 30–45 | |
| Sucker spines (length in $\mu$) | — | 8 | 7 | — | — | 7–8 | 7–8 | |
| Testes (number) | 20 | 14–17 | 19–22 | 18–24 | 15–20 | 18–20 | 15–25 | 20–24 |
| Testes (diameter in $\mu$) | 30–40 | 40 | 78 × 72 | — | — | 40 | 70–80 × 40–45 | 45–60 × 23–37 |
| Cirrus sac (length × diameter in $\mu$) | 120 | 87–114 × 76 | 90–111 × 30–42 | 120 × 55 | Ca. 100 (from drawing) | 100 × 70 | 100 × 46–58 | 110–125 × 15–25 |
| Eggs (number/capsule) | 8–10 | 4–6 | 5–6 | 4–9 | 6 | 15 | — | 6–9 |
| Eggs (diameter in $\mu$) | — | — | 50 × 43 | — | — | 50 | — | 28–32 × 20–25 |
| Oncospheres (diameter in $\mu$) | — | 15·2 | 17 × 14 | — | — | 19–23 | — | 14 |
| Genital apertures (arrangement) | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral | Unilateral |
| Avian host (order) | Psittaciformes | Columbiformes | Columbiformes | Columbiformes | Piciformes | Galliformes | Coliiformes | Columbiformes |

an internal nor an external seminal vesicle, although in fully-mature and gravid proglottides, the vas deferens becomes greatly swollen with sperm and may act as an external seminal vesicle. In early proglottides the vas deferens tends to lie along the anterior edge of the segment, but, as it becomes filled with sperm, it comes to occupy most of the anterior poral quarter of each proglottis and lies in large loose coils.

The ovary is fanlike and deeply lobed with a maximum breadth of about 300 $\mu$ and lies ventrally in a median position. The vitelline gland, lying immediately posteriorly and slightly porally to the ovary, is irregularly ovoid and measures 104–180 $\mu \times$ 65–100 $\mu$. The shell-gland, with a diameter of about 15 $\mu$, lies between the ovary and the vitelline gland. On leaving the genital atrium, the vagina lies parallel to the anterior margin and widens out, before reaching the centre of each proglottis, to form a receptaculum seminis.




Figs. 23 and 24. *Raillietina* (*Paroniella*) *siamensis* Schmelz, 1941. Mature proglottis (Fig. 23), and egg with contained oncosphere (Fig. 24).

The uterus can first be seen as a transverse band across the anterior region of the proglottis, and it eventually breaks down to form uterine capsules, each of which contains but one egg. The size of the capsules is 34–38 $\mu \times$ 30–32 $\mu$; the diameter of the contained eggs (Text-fig. 24) is 25–27 $\mu \times$ 22–24 $\mu$; and the diameter of the embryos is 9–15 $\mu$. The oncosphere hooks are small, measuring 7–9 $\mu$ in length.

Discussion. As can be seen from Table VIII, the present material agrees closely with that described by Schmelz (1941) as *Raillietina* (*Paroniella*) *siamensis* and also with material described by Johnston (1914) as *Davainea sphecotheridis*. Schmelz separated his species from that of Johnston on the following grounds:

(a) *sphecotheridis* is a parasite of Passeriformes whereas *siamensis* is found in Capitoniformes;
(b) The scolex of *sphecotheridis* bears a great number of minute spines, particularly at the base of the rostellum, whereas *siamensis* does not have these;
(c) there are fewer and smaller testes in *sphecotheridis* than in *siamensis*;
(d) the rostellar hooks are smaller in *sphecotheridis*, and there appear also to be differences in the length and breadth of the strobila, in the length of the cirrus-sac and in the diameter of the embryo.

## Table VIII

Comparison of Borneo material with *Davainea sphecotheridis* and *Raillietina siamensis*

| Species: | *Davainea sphecotheridis* | *Raillietina siamensis* | Borneo material |
|---|---|---|---|
| Strobila: (length × max. breadth in mm.) | 100 × 2 | 45 × 4·8–4·9 | 35 × 1·15 |
| Scolex (diameter × length in μ) | 360 | 400–440 × 240 | 490–525 × 360 |
| Rostellum (diameter × length in μ) | — | 130–150 | 174–215 × 85–150 |
| Rostellar hooks (number) | very great number | 240 | 200–300 |
| Rostellar hooks (length in μ) | ant. row: 20<br>post. row: 15 | ant. row: 24<br>post. row: 20 | ant. row: 28<br>post. row: 19–23 |
| Suckers (diameter in μ) | 140 | 200 | 174–215 × 140–178 |
| Sucker spines (length in μ) | up to 10 | — | 8–18 |
| Testes (number) | ca. 30 | 50–60 | 20–40 |
| Testes (diameter in μ) | 25–30 × 15–20 | 80 × 60 | 40–90 × 37–68 |
| Cirrus sac (length × diameter in μ) | 100 × 40 | 150–160 × 66–68 | 90–130 × 60–74 |
| Ovary (shape and size in μ) | digitiform lobes | 495 | fanlike, deeply lobed; 300 |
| Vitelline gland (shape and size in μ) | solid and rounded | 145 | irregularly ovoid 104–180 × 65–100 |
| Egg capsule (diameter in μ) | 27 × 20 (egg) | 30–36 | 34–38 × 30–32 |
| Embryo (diameter in μ) | 17 | 12–14 | 9–15 |

However, it is clear from the present material that some of these characters which purportedly separate these species are, in fact, common to both. The minute hooks described by Johnston on the scolex of *sphecotheridis* are abundantly clear in the present material but only when the rostellum is not evaginated, which would suggest that they are extremely caducous and which might well explain why Schmelz did not see any such spines, although he was looking for them, in his material. The number of testes in the present material seems to fall half-way between the number described for *sphecotheridis* and the number described for *siamensis*, and it is quite possible that the number of testes is a variable character within the limits quoted. The difference in the sizes of rostellar hooks seems hardly sufficient for this not to be due to measuring technique, particularly in view of the fact that when the hooks of the present material were measured from whole mounts in Canada balsam the lengths were considerably lower than those actually recorded from squash preparations in Berlese fluid.

In view of the number of small discrepancies present between the two species, it may be that they are in fact separate species, but the present material suggests that there is a range of variation which may well encompass both described species. However, without examining the type-material of *sphecotheridis* and that of *siamensis*, it would not be wise to make these two species synonymous and accordingly the

present material is tentatively identified as *Raillietina* (*Paroniella*) *siamensis*, as it seems to fit Schmelz's description slightly better than that of Johnston, but it is strongly suggested here that *siamensis* is a synonym of *sphecotheridis*.

It is probable that there is a mistake in labelling in some of the present material as a Charadriiform bird, namely *Charadrius leschenaultii*, is apparently a host for this species, whereas this order of birds has not previously been shown to carry species of *Raillietina* (see discussions following descriptions of *Raillietina* (*R.*) *johri* Ortlepp, 1938 and *Kowalewskiella susanae* n. sp.).

Furthermore, no differences could be found between those worms supposedly from *Charadrius leschenaultii* and those worms from the piciform hosts.

## Family **HYMENOLEPIDIDAE** Fuhrmann, 1907

### Genus ***HYMENOLEPIS*** Weinland, 1858

### ***Hymenolepis mahonae*** nom. nov.

(Text-figs. 25–28)

*Hymenolepis fringillarum* of Mahon, 1958, *nec* Rudolphi, 1810.

Host. *Aegithina tiphia* 9045.

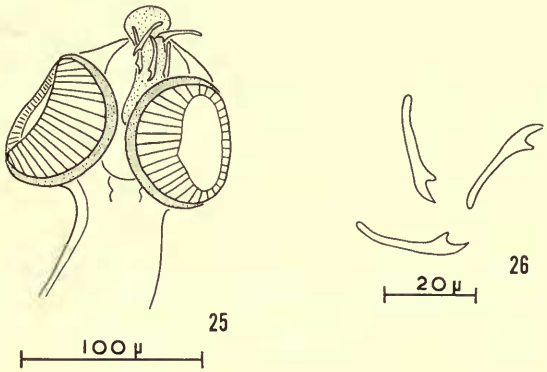
There were several worms present only two of which, however, possessed scolices. Of these two, only one (Text-fig. 25) bore rostellar hooks. The longest complete worm measures 7 mm. and has a maximum diameter of 0·5 mm. There are fragments present, however, where the maximum breadth is almost 0·8 mm. The proglottides are all broader than long, the ratio of breadth to length varying from 3 : 1 to 8 : 1 depending on the part of the worm. The genital apertures are unilateral and the genital ducts pass dorsally to both the ventral and the dorsal excretory vessels.

The scolex is 96 $\mu$ long and 140 $\mu$ in maximum breadth across the widest part. There are four, apparently unarmed, suckers which measure 62–74 $\mu \times$ 50–56 $\mu$. The rostellum, 82 $\mu$ long by 64 $\mu$ in diameter, bears 10 hooks which are 23–28 $\mu$ long (Text-fig. 26).

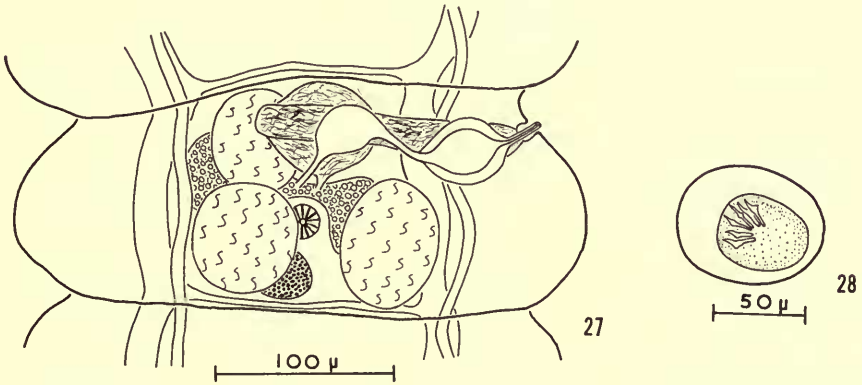
The three testes are arranged in a triangle (Text-fig. 27) with one poral and posterior, one aporal and posterior, and one aporal and anterior. The testes measure 60–65 $\mu \times$ 49–61 $\mu$. There are both external and internal seminal vesicles. The external seminal vesicle is 25–35 $\mu$ in diameter and lies anteriorly about the centre of the proglottis. The internal seminal vesicle is larger and measures 40–50 $\mu$ in diameter. The cirrus-sac was not clearly seen, but appears to be about 65–75 $\mu$ long by about 40 $\mu$ in diameter.

The ovary, bilobed and central, measures up to about 200 $\mu$ across its total width, by 50–80 $\mu$. Posterior to the ovary, and lying slightly aporally is the compact vitelline gland which measures 50–55 $\mu \times$ 36–41 $\mu$. The receptaculum seminis lies prominently in the anterior, median portion of each proglottis and, when full of sperm, reaches a size of 52–70 $\mu \times$ 48–55 $\mu$.

The present specimens are not sufficiently well preserved to allow the elucidation of details of uterus development. The eggs, however, are 42–48 $\mu$ in diameter (Text-fig. 28) while the contained oncospheres are 26–32 $\mu$ × 20–30 $\mu$. The hooks of the oncosphere measure 18–20 $\mu$ in length.




FIGS. 25 and 26. *Hymenolepis mahonae* nom. nov. Scolex (Fig. 25), and rostellar hooks (Fig. 26).




FIGS. 27 and 28. *Hymenolepis mahonae* nom. nov. Mature proglottis (Fig. 27), and egg (Fig. 28).

DISCUSSION. The present material agrees well with material described by Mahon (1958) as *Hymenolepis fringillarum* (Rudolphi, 1810). Mahon's description, however, does not agree sufficiently well with the description of Rudolphi (1810), nor with the description of Joyeux and Baer (1936), to allow for its inclusion in the specise *fringillarum*. For purposes of comparison, Mahon includes the figures quoted by Joyeux and Baer in her description, and although the scolex in her material has a diameter of less than half that of the worms described by Joyeux and Baer, and although the cirrus-sac in her material is only a little over half the size of the cirrus sac in the other material, she still identified her material as *H. fringillarum* (see Table IX). It is proposed here that the worms, identified by Mahon as *Hymenolepis fringillarum*, are, in fact, identical with the present material and represent a new

species. The new species has been given the patronymic *mahonae* in honour of Dr. June Mahon who first described it. Table X shows all the species of *Hymenolepis* (*sensu lato*), which possess 10 rostellar hooks, so far recorded from Passeriformes and serves to illustrate the differences between the new species and the other existing species. In order to facilitate comparison of the species, it was thought better to retain the generic term *Hymenolepis* (*sensu lato*) despite the work of Spassky and Spasskaja (1954) and Yamaguti (1959) who have sub-divided this vast genus into many smaller genera employing, unfortunately, what in some cases may be regarded as questionable criteria for erecting new genera.

## Table IX

*Hymenolepis fringillarum* (Rudolphi, 1810) compared with *H. fringillarum* of Mahon (1958) and present material from Borneo

| Species: | *fringillarum* (Rudolphi, 1810) | *fringillarum* (Mahon, 1958, *nec* Rudolphi, 1810) | *mahonae* nom. nov. |
|---|---|---|---|
| Description taken from: | Joyeux & Baer (1936) Lopez-Neyra (1942) Mettrick (1958) | Mahon (1958) | |
| Strobila (length × max. breadth in mm.) | 32–100 × 0·8–1 | — | 7 × 0·5(0·8) |
| Scolex (diameter in μ) | 210–300 | 127–145 | 140 |
| Rostellar hooks (number) | 10 | 10 | 10 |
| Rostellar hooks (length in μ) | 26–28 | 26 | 23–28 |
| Suckers (diameter in μ) | 90–100 × 100–120 | 54–58 × 76–79 | 50–56 × 62–74 |
| Testes (diameter in μ) | 150–170 | — | 49–61 × 60–65 |
| Cirrus sac (length × diameter in μ) | 95–110 × 40 | 54 × 40 | 65–75 × 40 |
| Eggs (diameter in μ) | 57 × 34 | — | 42–48 |
| Oncospheres (diameter in μ) | 48 × 36 | — | 26–32 × 20–30 |
| Oncosphere hooks (length in μ) | 20 | — | 18–20 |
| Genital apertures (arrangement) | Unilateral | Unilateral | Unilateral |

It should be mentioned that Spassky and Spasskaja (1954) transferred *H. fringillarum* to one of their new genera, namely *Passerilepis*, and Yamaguti (1959) lists *fringillarum* as a synonym of *Passerilepis passeris* (Gmelin, 1790). Mettrick (1958), however, redescribed *fringillarum* retaining both the older generic name of *Hymenolepis* and also the specific name of *fringillarum*, but he did not discuss any possible synonymy of this worm. Although there may be valid reasons for retaining both specific names, *fringillarum* (Rudolphi, 1810) is listed in Table X with *passeris* (Gmelin, 1790) in accordance with Ransom (1909) and Yamaguti (1959).

## TABLE X

*Hymenolepis* species with 10 rostellar hooks within the range 23–30$\mu$ long from Passeriformes.

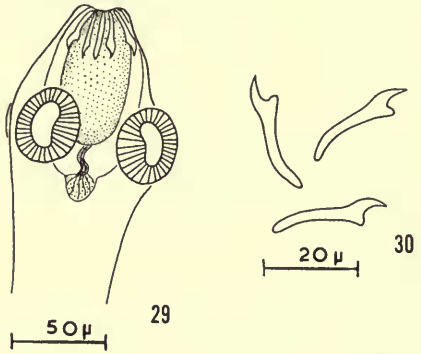
| Species: | *farciminosa* (Goeze, 1782) | *hemignathi* (Shipley, 1897) | *magniovata* (Fuhrmann 1918) | *passeris* (Gmelin, 1790) =*fringillarum* (Rudolphi, 1810) | *serpentulus* (Schrank, 1788) | *stylosa* (Rudolphi, 1810) | *zosteropis* (Fuhrmann, 1918) | *mahonae* n. sp. |
|---|---|---|---|---|---|---|---|---|
| Description taken from: | López-Neyra (1942*a*/*b*) Mettrick (1958) | Shipley (1897) | López-Neyra (1942*a*/*b*) | Joyeux & Baer (1936) López-Neyra (1942*a*/*b*) Mettrick (1958) | Hughes (1941) López-Neyra (1942*a*/*b*) Mettrick (1958) | Hughes (1941) López-Neyra (1942*a*/*b*) Mettrick (1958) | Hughes (1941) | — |
| Strobila (length × max. breadth in mm.) | 82–120 × 1–1·2 | 10–22 × 2 | 25 × 0·4 | 32–100 × 0·8–1 | 60–200 × 1·8–2·5 | 80–110 × 1–1·8 | 22 × 0·7 | 7 × 0·5(0·8) |
| Scolex (diameter in $\mu$) | 180–265 | — | 160 | 210–300 | 250–350 | 200–280 | 200 | 140 |
| Rostellum (diameter in $\mu$) | 100 | — | 50 | — | 50 | 80–100 | — | — |
| Rostellar hooks (number) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Rostellar hooks (length in $\mu$) | 18–24 | 18–23 | 30 | 26–28 | 18–27 | 28–38 | 30–32 | 23–28 |
| Suckers (diameter in $\mu$) | 85–95 | — | 70 | 100–120 × 90–100 | 75–120 | 85 × 60 | 88 | 62–74 × 50–56 |
| Testes (diameter in $\mu$) | 90–100 | — | — | 150–170 | 150–200 | 120–150 | — | 60–65 × 49–61 |
| Cirrus sac (length × diameter in $\mu$ | 180–300 × 45 | — | 100–120 × ? | 95–100 × 40 | 130–190 × 85–110 | 200–270 × 70–140 | 120–140 × ? | 65–75 × 40 |
| Eggs (diameter in $\mu$) | 48–60 × 36–65 | 40–50 | 45 | 57 × 34 | 110 × 85 | — | 50–60 | 42–48 |
| Oncospheres (diameter in $\mu$) | 36–48 × 26–30 | — | 32–36 | 48 × 36 | 36–65 × 28–40(20–24) | 40–48 × 32–40 | 23 | 26–32 × 20–30 |
| Oncosphere hooks (length in $\mu$) | 20 | 20 | — | 20 | 20–22 | 18–20 | — | 18–20 |
| Avian host (order) | Passeriformes | Passeriformes | Passeriformes | Passeriformes | Passeriformes | Passeriformes | Passeriformes | Passeriformes |

## *Hymenolepis* sp.

(Text-figs. 29–32)

Hosts. *Anthreptes malacensis* 9318, 9358; *Nectarinia calcostetha* 9092.

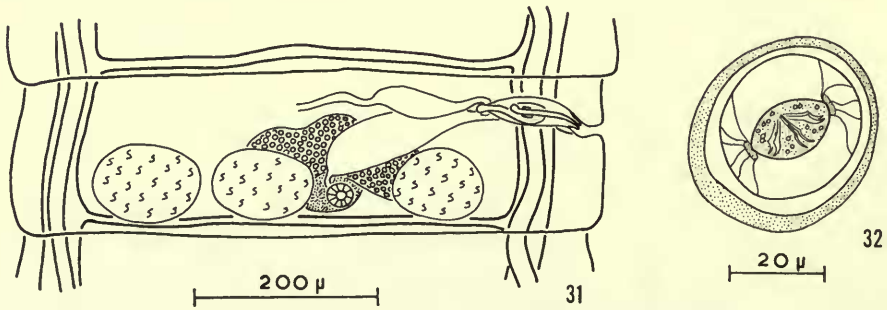
Mature worms measure up to 30 mm. long by 0·35–0·46 mm. in maximum breadth. The genital apertures are irregularly alternating and the genital ducts pass dorsally to both the longitudinal excretory vessels.




Figs. 29 and 30. *Hymenolepis* sp. Scolex (Fig. 29) and rostellar hooks (Fig. 30).

The scolex (Text-fig. 29) measures 104–121 $\mu$ × 115–126 $\mu$ and bears an armed rostellum and four, apparently unarmed, suckers. There are 8 hooks (Text-fig. 30) on the rostellum and these measure 28–36 $\mu$ long. The suckers are 46–56 $\mu$ × 33–49 $\mu$.

The three testes (Text-fig. 31) lie in a straight line and, when mature, measure 64–110 $\mu$ × 48–67 $\mu$. The cirrus-sac is 78–88 $\mu$ long and has a diameter of 25–33 $\mu$. Although the cirrus was not seen in an extruded position, it could be seen lying within the cirrus-sac and has a diameter of about 6 $\mu$. There is present both an external and an internal seminal vesicle, the latter measuring 21–25 $\mu$ × 15–23 $\mu$. The vas deferens is slightly coiled and lies anteriorly to the cirrus-sac, roughly parallel to the anterior edge of the proglottis.




Figs. 31 and 32. *Hymenolepis* sp. Mature proglottis (Fig. 31), and egg with enclosed oncosphere (Fig. 32).

The ovary is distinctly trilobed and lies in the middle of the proglottis. The vitelline gland, lying immediately posteriorly to the ovary, is compact, measures 65–85 $\mu \times 43$–52 $\mu$, and lies ventrally to the middle testis. The receptaculum seminis is large and increases to a maximum size of 163 $\mu \times 80$ $\mu$, although in most mature proglottides it measures about 140 $\mu$ by about 70 $\mu$.

There is a sudden transition between mature and gravid proglottides, the eggs being only just visible in the last mature proglottis and filling the whole of the medulla, extending beyond the excretory vessels, in the first gravid proglottis. The eggs (Text-fig. 32) measure 25–40 $\mu$ in diameter and the contained oncospheres are 10–14 $\mu$ in diameter. The hooks of the oncosphere are 7–9 $\mu$ long.

Discussion. The present material does not resemble any species listed by Fuhrmann (1932), Lopez-Neyra (1942*a*, *b*), or by Yamaguti (1959) as coming from Passeriformes. However, in view of the fact that it has not been possible to examine all the references to *Hymenolepis* (*sensu lato*) it was considered advisable not to erect a new species to contain this worm at this time.

## Genus ***FIMBRIARIA*** Frölich, 1802

### ***Fimbriaria fasciolaris*** (Pallas, 1781)

Host. Domestic duck (*Anas boschas* L. *dom.*) 9575.

Specimens are greatly contracted, but appear to fit the description by Wolffhügel (1936), who also lists the full synonomy of this species. Webster (1943*a*), in his review of the Fimbriariinae, mentions that he found a smaller range in the number of longitudinal muscle-bundles in *F. fasciolaris* than is quoted by Wolffhügel, the former finding only 110–120 in his material whereas Wolffhügel gives the range as 60–120. Although the present material is not well enough preserved for any description, its similarity both to the worms described by Wolffhügel (1936) and to specimens in the Helminthological collection of the British Museum (Natural History) identified as *Fimbriaria fasciolaris* makes identification reasonably positive.

## Family **DILEPIDIDAE** Fuhrmann, 1907

## Genus ***PARICTEROTAENIA*** Fuhrmann, 1932

### ***Paricterotaenia burti*** Sandeman, 1959

(Text-fig. 33)

Host. *Charadrius leschenaultii* 9110.

One, small immature worm was present which measured 0·35 mm. long by 0·12 mm. in maximum breadth. Only two immature proglottides were present, both being twice as broad as long.

The scolex (Text-fig. 33) is 200 $\mu \times 240$ $\mu$ and possesses four unarmed suckers, 120–140 $\mu \times 100$–110 $\mu$. The rostellum, 150 $\mu$ long by 70 $\mu$ in diameter, bears 16 hooks arranged in what appears to be a single row. The hooks are 50–52 $\mu$ long. No genitalia were seen at all.

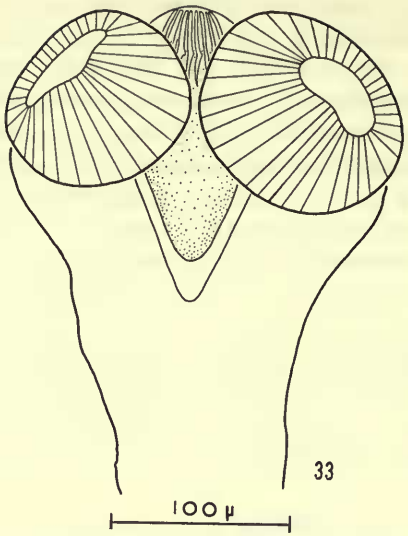



FIG. 33. *Paricterotaenia burti* Sandeman, 1959. Scolex.

DISCUSSION. The present material appears to agree sufficiently well with *Paricterotaenia burti* Sandeman to warrant identification with that species. Sandeman (1959*a*) erected the species to contain worms he found in *Lymnocryptes minimus* and *Numenius arquatus* from the River Eden, Fife, and also to contain, in part, *Paricterotaenia stellifera* (Krabbe, 1869). In the original description of *P. stellifera* Krabbe gives two sets of hook characteristics: one with 10 hooks, 55 μ long; and the other with 14 hooks of length 46–51 μ. The former set of hook characters is that which has become ascribed to *P. stellifera* (Krabbe, 1869) while the latter, prior to Sandeman, had been ignored. Hooks of the present material agree closely with those drawn and described by Krabbe and also those described by Sandeman which pertain to *P. burti*. The measurements of the scolex and rostellum also agree reasonably closely with Sandeman's description and, furthermore, the worm described by Krabbe, by Sandeman, and the present worm were all found in Charadriiformes. This appears to be the first record of this worm in Asia.

## Genus ***DILEPIS*** Weinland, 1858

### ***Dilepis ardeolae*** Singh, 1952 (?)

(Text-fig. 34)

HOST. *Butorides striatus* 9040.

The worms are small, measuring up to about 3 mm. long by 0·25 mm. in maximum breadth. The genital apertures are unilateral.

The scolices are all missing, although several worms are present.

There are 7 testes (Text-fig. 34) lying mainly posteriorly and dorsally to the female genitalia and measuring 30–40 μ in diameter. In some proglottides, the testes can be seen extending laterally and anteriorly to the ovary on the aporal side. Neither an internal nor an external seminal vesicle was seen. The cirrus-sac,

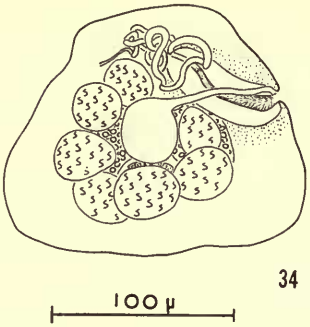



FIG. 34. *Dilepis ardeolae* Singh, 1952 (?) Mature proglottis.

though not seen clearly, appears to measure about 80 $\mu$ long by about 25 $\mu$ in diameter, but this is probably a low figure as there were no gravid proglottides present for comparison. The cirrus is armed, but was not seen in the extruded position. In the anterior region of maturing proglottides, the vas deferens becomes profusely coiled and probably serves as an external seminal vesicle when it swells up with sperm.

Lying approximately in the middle of the proglottis is the bilobed ovary, each lobe tending to be more or less spherical. The vitelline gland, lying immediately posteriorly to the ovary, is compact and measures about 30 $\mu \times 20$ $\mu$. In the majority of cases, the vagina opens into the genital atrium posteriorly to the opening of the cirrus-sac, but this is not constant. Towards the centre of the proglottis the vagina opens into a receptaculum seminis which is broadly fusiform.

DISCUSSION. The only feature in which the present material differs from that described by Singh (1952) as *Dilepis ardeolae* is the size of the cirrus-sac. In Singh's material the length of the cirrus-sac is given as 0·248–0·31 mm. and the diameter as 0·031–0·037 mm. The cirrus-sac in the present material, however, appears to be much smaller, being only about 80 $\mu$ long by 25 $\mu$ in diameter, but as there are no gravid proglottides present it is difficult to state whether the size of cirrus-sac measured is the largest size in a complete worm. Despite the apparent discrepancy in size of cirrus-sac, the other characters are in such close agreement that the present worms are tentatively identified as *Dilepis ardeolae* Singh, 1952. Moreover, the fact that the host *Ardeola grayi* from which Singh described his species, is closely related both in habitat and phylogenetically to *Butorides striatus*, the host from which the present material comes, further suggests that the worms may be of the same species.

## Genus ***LIGA*** Weinland, 1857

### ***Liga facile*** (Meggitt, 1927) Szpotanska, 1931

(Text-figs. 35–36)

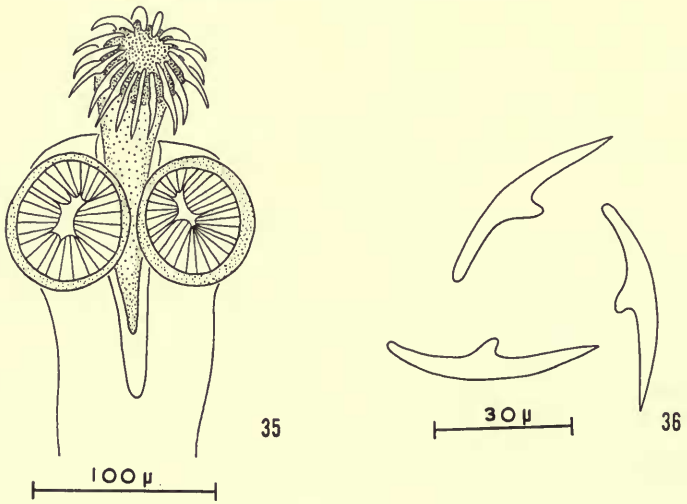
*Anomotaenia facile* Meggitt, 1927.
*Anomotaenia trivialis* Meggitt, 1927.

HOST. *Actitis hypoleucos* 9196.

The worms are very small, not exceeding 1 mm. in length, and without exception are immature, no genitalia being seen at all. The maximum breadth in all the worms

present is the breadth of the scolex across the region of the suckers, as in no instance does the breadth of any of the proglottides exceed the breadth of the scolex.

The scolex (Text-fig. 35), including the rostellum, measures 160–170 $\mu$ in length and is 130–150 $\mu$ broad. The suckers measure 79–82 $\mu \times$ 72–76 $\mu$ and are unarmed. There are, however, some marks which may be the scars of attachment of acetabular spines along the posterior edge of the suckers. The rostellum, measuring 80–100 $\mu$ long by 40–60 $\mu$ in diameter, bears 20 hooks in two alternating rows. The hooks (Text-fig. 36) in each row are of different sizes: those lying posteriorly measure 41–43 $\mu$ long, while those lying anteriorly measure 46–51 $\mu$ long.




FIGS. 35 and 36. *Liga facile* (Meggitt, 1927). Scolex (Fig. 35) and rostellar (hooks Fig. 36).

DISCUSSION. The present material differs only slightly from that described by Meggitt (1927*b*) in that the scolex of Meggitt's material is 270 $\mu \times$ 290 $\mu$, whereas the scolex in the present material is 130–150 $\mu \times$ 160–170 $\mu$. In view of the close correlation, however, which obtains in the number and size of the rostellar hooks, the size of the rostellum, the small size of the whole worm; and, furthermore, in the fact that both worms are parasites of wading birds, it seems reasonable to identify the present material as *Liga facile* (Meggitt, 1927).

Szpotanska (1931) reviewed the genus *Liga* Weinland, 1857, and transferred *Anomotaenia facile* Meggitt, 1927, and *A. trivialis* Meggitt, 1927, to this genus. She regarded *trivialis* as a synonym of *facile* and redescribed the latter species using new material from *Burhinus oedicnemus*. Sandeman (1959*a*), while accepting that both species belong to the genus *Liga*, nevertheless regards *facile* and *trivialis* as distinct species, but has not yet published his evidence for this view. Williams (1962), however, having examined the type-material of both *facile* and *trivialis*, supports the view of Szpotanska that the two species are not distinct. On the basis

of his comparison of Meggitt's type-material with the descriptions of both Meggitt and Szpotanska, he states, in his detailed review of the genus *Liga*, that there seems to be " scant evidence for regarding *A. facile* and *A. trivialis* as distinct species ". The main feature of difference between *facile* and *trivialis* from Meggitt's description is the size of the rostellar hooks. In *A. facile* the hooks are 40–50 $\mu$ long, while in *A. trivialis* the hooks are 38–39 $\mu$ long. As can be seen in the present material, however, the hooks in the anterior row are longer than those in the posterior row. Accordingly, it is not improbable that Meggitt measured hooks from both rows in the material he described as *A. facile*, but measured only hooks in the posterior row in the material he described as *A. trivialis*. The fact that Williams (1962), on re-examining the type-specimens of *A. trivialis*, found hooks as long as 45 $\mu$ supports this postulation. Therefore, there appears to be no justification for regarding *facile* and *trivialis* as distinct species.

## Genus ***ANOMOTAENIA*** Cohn, 1900

### ***Anomotaenia depressa*** (Siebold, 1836) Fuhrmann, 1908

(Text-figs. 37–39)

*Taenia depressa* Siebold, 1836.
*Liga frigida* (Meggitt, 1927).

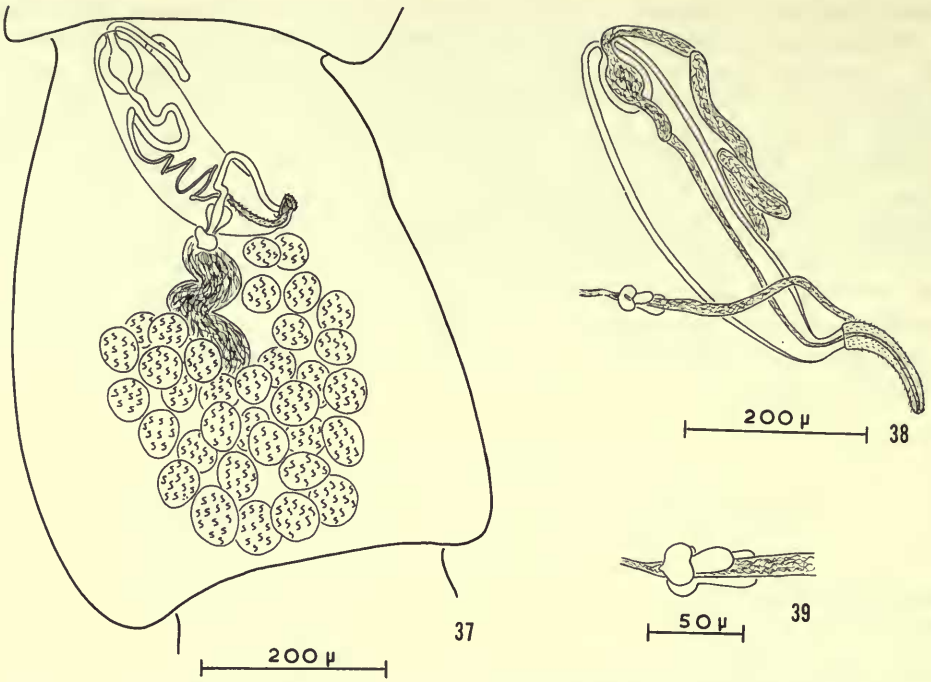
Host. *Apus affinis* 8784.

The present material comprises fragments, all of which probably come from a single worm. The total length of all the fragments is 8 mm. and the maximum breadth is 0·6 mm. The immature proglottides at first tend to be rather square in shape, but as they mature they become longer than broad. The genital apertures are irregularly alternating.

The scolex is missing.

There are 30–40 testes (Text-fig. 37) which surround the female genitalia laterally and posteriorly and which measure 40–70 $\mu$ in diameter. The cirrus-sac (Text-fig. 38) is large, with a length of 400–480 $\mu$ and a diameter of 80–100 $\mu$. The cirrus appears to be fairly short when extruded, having a maximum observed length of 150 $\mu$. The diameter of the cirrus base is about 30 $\mu$ and the diameter of the tip is 12 $\mu$. The cirrus is covered for most of its length with fine spines about 4–5 $\mu$ long. There is no external seminal vesicle present, but the vas deferens, on entering the cirrus-sac, expands to form an internal seminal vesicle in the proximal part of that organ. The ductus ejaculatorius is quite narrow and lies convoluted in the distal part of the cirrus-sac before entering the cirrus.

The deeply-lobed ovary is situated posteriorly and ventrally to the cirrus-sac which, in some proglottides, overlies part of the ovary. The vitelline gland, lying posteriorly to the ovary and anteriorly to the testes, is irregularly lobular. The vagina has its opening into the genital atrium posterior to that of the cirrus-sac and lies parallel to the cirrus-sac until it eventually leads into the receptaculum seminis through a peculiar, " chitinoid " structure (Text-fig. 39). This structure is roughly dumb-bell shaped and has a length of 55–57 $\mu$. The diameter of the part




FIGS. 37–39. *Anomotaenia depressa* (Siebold, 1836). Mature proglottis showing male genitalia and vagina (Fig. 37), cirrus-sac and part of the vagina (Fig. 38), and chitinoid vaginal apparatus (Fig. 39).

closest to the vagina is the same as the diameter of the part next to the receptaculum seminis and measures 27–29 μ. The diameter of the narrow constriction is 8–10 μ. The receptaculum seminis, situated immediately behind the cirrus-sac and dorsal to the vitelline gland, has a twist in it and when filled with sperm reaches up to 100 μ in overall length by about 40 μ in diameter.

Gravid proglottides are not present.

DISCUSSION. Although the scolex is missing and gravid proglottides are not present, this worm is almost certainly the same species as that described by Joyeux and Baer (1936) from *Apus apus*. Through the kindness of Professor J. G. Baer, I have had a chance to compare the above material with worms from his own collection which he had identified as *Anomotaenia depressa* and undoubtedly the worms were identical.

The " chitinoid " structure present at the junction of the vagina and the receptaculum seminis was described by Joyeux and Baer (1936) thus: " Le vagin est entouré, près du réceptacle séminal, d'un manchon cellulaire, auquel fait suite un appareil de fermeture chitineaux, à l'entrée de ce réceptacle." In order to measure the structure in the present material accurately, two proglottides were mounted, unstained, in Berlese fluid which rendered most of the tissue transparent. Those structures which showed to advantage after this treatment were the cirrus-sac, the

narrow portion of the ductus ejaculatorius, the cirrus with its armature of spines, and the structure surrounding the vagina as it enters the receptaculum seminis.

Dollfus (1958, p. 515), in a footnote, suggests that the structure may be made of a scleroprotein, but that its chemical nature is not known. In the same paper Dollfus reviews those species belonging to the genera *Anomotaenia* Cohn, 1900; *Pseudangularia* Burt, 1938(*a*); *Neoangularia* Singh, 1952; and *Neoliga* Singh, 1952; which possess this structure which he describes as " un appareil occlusif entre le réceptacle séminal et le vagin distal ".

Dollfus (1958) discusses fully the complicated synonymy of *Anomotaenia depressa* (Siebold, 1836) and cites all the descriptions of note. Most of these descriptions are inadequate on their own, and accordingly Dollfus gives a compound description which takes into account those given by Krabbe (1869), von Linstow (1897), Fuhrmann (1899*a*), López-Neyra (1923), Joyeux and Timon-David (1934) and which agrees with data taken from his own material. In the résumé of his paper Dollfus stresses the insufficiency of present knowledge of both *Anomotaenia depressa* (Siebold, 1836) and *A. cyathiformis* (Frölich, 1791), particularly as both these species have been described both from Passeriformes and Cypseliformes. Furthermore, several authors have used, for descriptions of *cyathiformis*, characters of worms taken from hosts belonging to both these orders. A more recent, though short, description of *A. depressa*, which agrees with that of Joyeux and Baer (1936), is given by Vojtechovska-Mayerova (1952).

## *Anomotaenia nymphaea* (Schrank, 1790)

(Text-figs. 40–41)

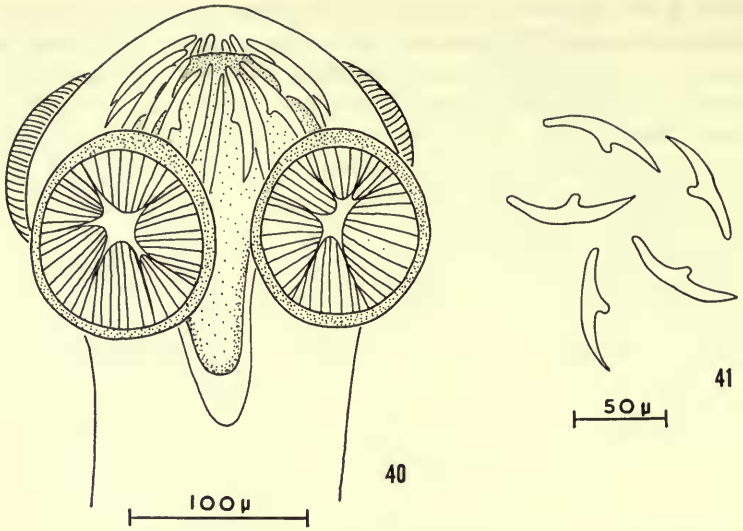
*Taenia nymphaea* Schrank, 1790

Host. *Numenius phaeopus* 9530.

Two, small immature worms only were present. Both had complete scolices with full complements of rostellar hooks. A squash preparation was made of one of the scolices while the other was mounted whole in Canada-balsam.

The longer of the two worms measures 0·75 mm. with a maximum breadth of 0·11 mm. The scolex (Text-fig. 40) is 200 $\mu$ long, including the length of the rostellar sac, and has a diameter of 250 $\mu$. The suckers are ovoid and measure 90–110 $\mu$ × 80–90 $\mu$. No sucker spines were seen. The rostellum is invaginated, measures 200 $\mu$ from its tip to the posterior extremity of the rostellar sac by 110 $\mu$ across the broadest part, and carries 20–22 hooks arranged in a double row. The rostellar hooks (Text-fig. 41) are of two sizes, the larger, lying anteriorly, are 75–80 $\mu$ long, while those in the posterior row are 65–70 $\mu$ long.

Discussion. The present material agrees well with material described by Joyeux and Baer (1936) and by Mahon (1958), although Mahon's material was probably in a greater state of relaxation than the present, as the diameter of the suckers in her material is considerably greater. Sandeman (1959*a*) has so far been unable to deal with the synonymy of this species, but is at present working on this.




FIGS. 40 and 41. *Anomotaenia nymphaea* (Schrank, 1790). Scolex (Fig. 40) and rostellar hooks (Fig. 41).

## *Anomotaenia tringae* (Burt, 1940) Sandeman, 1959

(Text-figs. 42–43)

*Paricterotaenia tringae* Burt, 1940.
*Anomotaenia paramicrorhyncha* Dubinina, 1953.

HOST. *Tringa glareola* 9255.

The worms measure up to 16 mm. long by 0·73 mm. in maximum breadth. In immature proglottides the breadth is about twice the length, but as the proglottides mature and become gravid, so does the ratio of length to breadth increase until in the gravid proglottides the length is about equal to the breadth. The genital apertures are 89% regularly alternating. The genital ducts pass between the dorsal and ventral excretory vessels.

Scolices are not present.

There are 9–11 testes (Text-fig. 42), most of which lie aporally, and they measure 45–70 $\mu$ × 25–40 $\mu$. There does not appear to be either an internal nor an external seminal vesicle. The cirrus-sac measures 87–100 $\mu$ long by 25–35 $\mu$ in diameter and has a typical constriction about halfway along its length. In many instances the unarmed cirrus could be seen projecting into the vagina.

The ovary is irregularly digitate, lies in the anterior third of mature proglottides, and stretches from the aporal excretory vessels almost to the poral excretory vessels. The slightly lobular vitelline gland lies posteriorly to the ovary, but in front of the testes, and measures 45–75 $\mu$ across. Lying to the poral side of the vitelline gland is the receptaculum seminis which is ovoid and measures 59–74 $\mu$ × 46–64 $\mu$ when not swollen with sperm, but when swollen reaches up to 130 $\mu$ × 70 $\mu$.

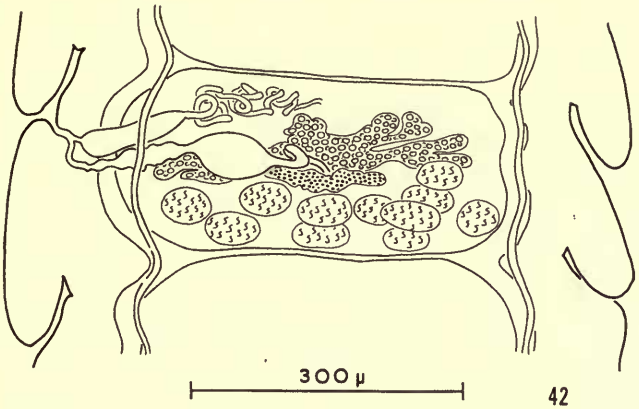



FIG. 42. *Anomotaenia tringae* (Burt, 1940). Mature proglottis.

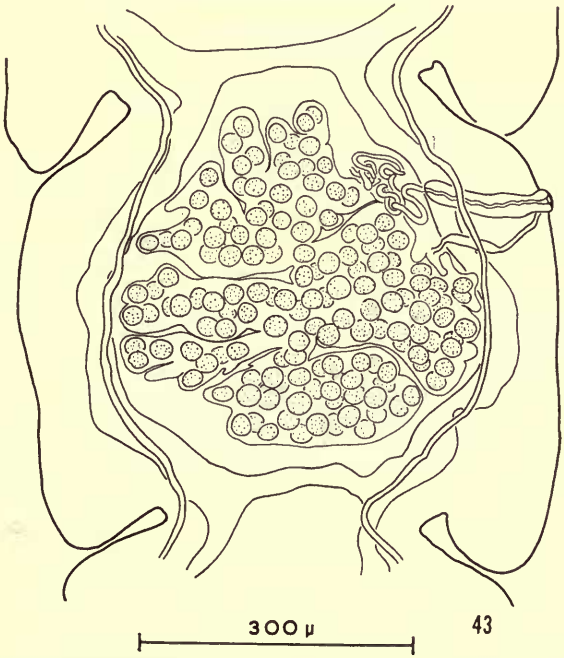



FIG. 43. *Anomotaenia tringae* (Burt, 1940). Gravid proglottis.

The uterus is sac-shaped initially, becomes increasingly lobular as the eggs ripen (Text-fig. 43), until in fully-gravid proglottides it tends to break down into pseudo uterine capsules. The eggs measure 34–39 $\mu \times$ 31–34 $\mu$ and the contained oncospheres are 25–30 $\mu \times$ 24–25 $\mu$. The hooks of the oncosphere were not fully formed.

DISCUSSION. The present material agrees well with the type-material of *Paricterotaenia tringae* which Mr. D. R. R. Burt has so kindly placed at my disposal, and with material described by Baer (1959). Despite the fact that the scolex is

wanting in the present material, such good correlation obtains through direct comparison of the rest of the anatomy with the type-material, that there remains no doubt as to the identity of the present worms. Sandeman, (1959*a*) transfers this species from the genus *Paricterotaenia* to the genus *Anomotaenia*. Burt (1940) states that owing to the fact that there does not exist a dilepid genus with a double crown of hooks and regularly alternating genital apertures " The choice lies therefore between *Anomotaenia* and *Paricterotaenia* ". Burt chose to place the species in the genus *Paricterotaenia* on the grounds that the scolex and rostellum are very similar to those seen in several species of *Paricterotaenia*. The transference of this species to *Anomotaenia* by Sandeman appears to be purely on the grounds of its possessing a double row of hooks and this is accepted by Baer (1959). Until such a time as Sandeman publishes his larger work on the dilepids of waders, and explains his justification for such a treatment, it is probably best to leave this species in the genus *Anomotaenia*.

## Genus ***PARVITAENIA*** Burt, 1940

### ***Parvitaenia*** sp.

(Text-fig. 44)

Host. *Butorides striatus* 9040.

The worm is incomplete, lacking a scolex. It measures 14 mm. in length by 0·9 mm. in maximum breadth. The proglottides are all broader than long and the genital apertures are irregularly alternating.

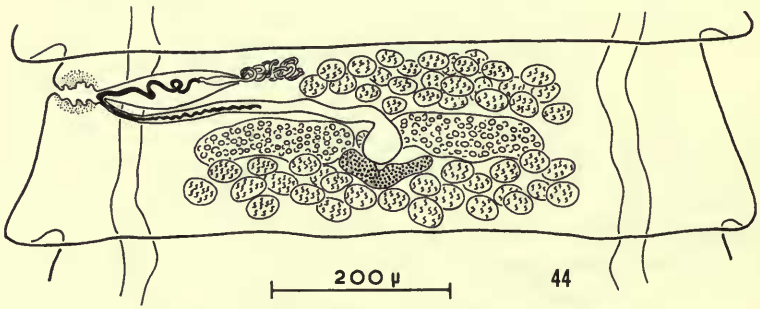



Fig. 44. *Parvitaenia* sp. Mature proglottis.

There are 50–52 testes (Text-fig. 44), half lying anteriorly to the female genitalia and half lying posteriorly, which measure 30–50 $\mu$ × 15–45 $\mu$. The cirrus-sac is not distinct, but appears to be about 115 $\mu$ long and 45 $\mu$ in diameter. It lies close to the anterior margin of the proglottis, opening into the genital atrium on the lateral margin. The cirrus is long and in many cases can be seen projecting into the vagina of the same proglottis and reaching almost to the receptaculum seminis.

The ovary is distinctly bilobed, the combined length of both lobes measuring 345–395 $\mu$. The vitelline gland, lying more or less in the centre of the proglottis and posterior to the ovary, is irregularly bilobed having a width of 90–110 $\mu$. Lying between the ovary and the vitelline gland is the roughly spherical shell-gland which has a diameter of about 45 $\mu$.

There are no gravid proglottides, but in the most mature of those present eggs can be seen accumulating in the anterior poral part of each proglottis. The parenchyma contains many calcareous corpuscles.

Discussion. It is not possible to identify this material as to species owing to the lack of a scolex. The internal anatomy, however, strongly suggests that it belongs to the genus *Parvitaenia* Burt, 1940. Baer and Bona (1960) slightly alter Burt's generic diagnosis and consider the genus to contain 13 valid species: *P. ardeolae* Burt, 1940; *P. macropeos* (Wedl, 1855); *P. cochlearii* Coil, 1955*a*; *P. purpurea* Johri, 1959; *P. magna* Baer, 1959; *P. macrophallica* Baer and Bona, 1960; *P. microphallica* Baer and Bona, 1960; *P. ambigua* Baer and Bona, 1960; *P. ardeae* (Johnston, 1911); *P. glandularis* (Fuhrmann, 1905); *P. aurita* (Rudolphi, 1819); *P. clavipera* Baer and Bona, 1960; and *P. pseudocyclorchida* Baer and Bona, 1960. Of these, five are new species and four are new combinations. The full descriptions of the new species are to be given at a later date and, until such time as these descriptions appear, simply allocating the present material to the genus *Parvitaenia* should suffice.

## Genus ***VITTA*** Burt, 1938

### ***Vitta rustica*** (Neslobinsky, 1911) Baer, 1959

(Text-figs. 45–46)

*Anomotaenia rustica* Neslobinsky, 1911.
*Vitta magniuncinata* Burt, 1938.

Host. *Hirundo rustica* 9202.

The strobila measures 25 mm. long by 2·5 mm. in maximum breadth. The proglottides are all broader than long, the ratio of breadth to length varying from 3 : 1 to 5 : 1 depending both on the state of contraction of the worm and on the site of the proglottis within the strobila. The genital apertures are irregularly alternating and situated laterally, close to the anterior margin of each proglottis, while the genital ducts pass dorsally to both the ventral and dorsal excretory vessels.

The scolex (Text-fig. 45) has a diameter of 370 $\mu$ and a length, including the length of the rostellum, of 330 $\mu$. The suckers are 73–81 $\mu \times$ 67–79 $\mu$ and are unarmed. The rostellum, 185 $\mu$ long by 165 $\mu$ in diameter, bears 42–45 hooks arranged in two rows in such a way that for every one hook in the anterior row, there are two hooks in the posterior row. The hooks are 50–60 $\mu$ long, those hooks in the posterior row being slightly longer than those of the anterior row.

There are 60–90 testes (Text-fig. 46) which, when fully developed, measure 62–77 $\mu \times$ 60–67 $\mu$, and which are arranged posteriorly and laterally to the vitelline gland and dorsally to the ovary. There is no external seminal vesicle as such, but the vas deferens expands in the region of the cirrus-sac and lies in large loose coils which function as an external seminal vesicle. On entering the cirrus-sac, the vas deferens forms an internal seminal vesicle. The cirrus-sac, lying parallel and close to the anterior margin of the proglottis, measures 320–360 $\mu$ long by 65–85 $\mu$ in diameter.

The ovary is bilobed, each lobe being fan-like and divided into a great number of smaller lobes which reach the excretory vessels on both sides of the proglottis.

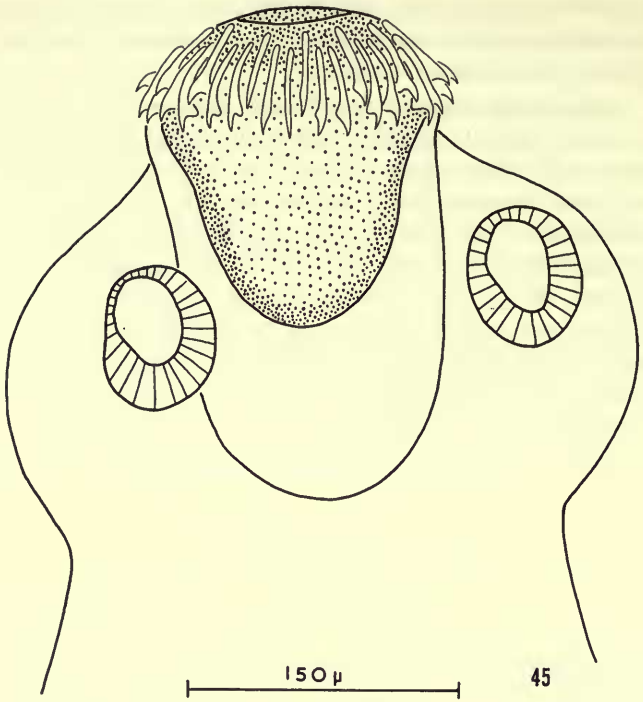



FIG. 45. *Vitta rustica* (Neslobinsky, 1911). Scolex.

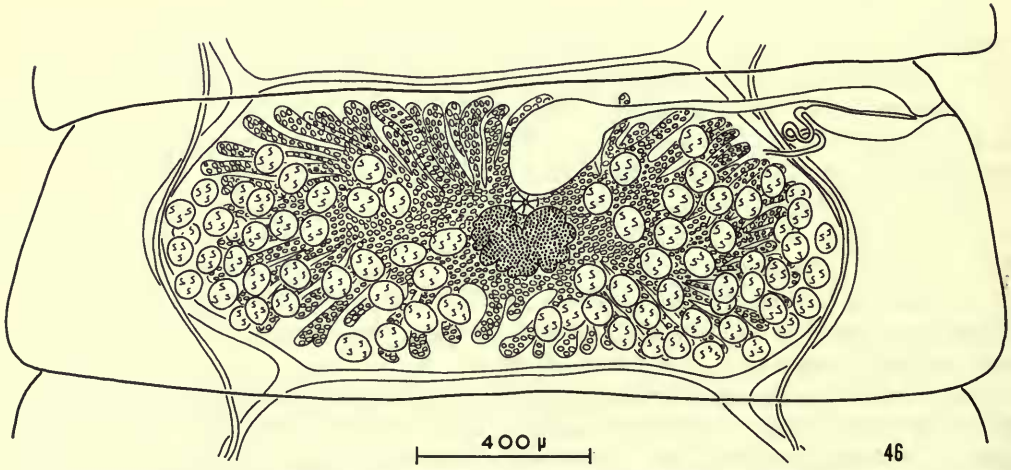



FIG. 46. *Vitta rustica* (Neslobinsky, 1911). Mature proglottis.

The vitelline gland is U-shaped and measures 90–110 $\mu$ × 50–70 $\mu$. Situated dorsally and slightly anteriorly to the vitelline gland is a well-defined shell-gland, 45 $\mu$ in diameter. In the more mature proglottides, the receptaculum becomes quite swollen, often exceeding the size of the cirrus-sac.

Discussion. The above material agrees well with that described by Burt (1938*b*) as *Vitta magniuncinata* and with that described by Baer (1959) as *V. rustica*. The genus *Vitta* was erected by Burt (1938*b*) to contain two different worms taken from *Hirundo rustica gutteralis* Scop., 1786, namely *magniuncinata* and *minutiuncinata*. The genus closely resembles *Anomotaenia* Cohn, the main feature of difference being that in *Anomotaenia* the genital ducts pass between the excretory vessels, whereas in *Vitta* they pass dorsal to both. Baer (1959) transfers *Anomotaenia rustica* Neslobinsky, 1911, to the genus *Vitta* and places *magniuncinata* as a synonym of *rustica*. He also provides a key to the four species of *Vitta* which he recognizes, using only the characters of hook number and size, and number of testes. These four valid species are: *V. parvirostris* (Krabbe, 1869); *V. minutiuncinata* Burt, 1938; *V. undulatoides* (Fuhrmann, 1908*b*); and *V. rustica* (Neslobinsky, 1911).

Yamaguti (1959) includes *Vitta* as a synonym of *Angularella* Strand, 1928, but gives no indication as to what grounds he has for this. The diagnostic characters of the genera differ essentially in the arrangement of the rostellar hooks. In *Vitta* there is a double row, whereas in *Angularella* there is a single row. On this basis, it is proposed to retain, as valid, the genus *Vitta* Burt, 1938.

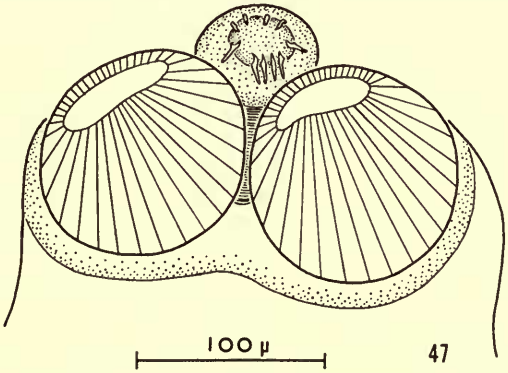
### ***Dilepidid*** sp.

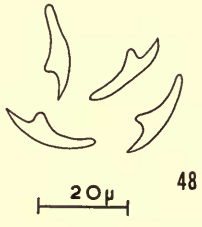
(Text-figs. 47–48)

Host. *Cacomantis merulinus* 9503.

The strobila measures 3·5 mm. long by 0·7 mm. in maximum breadth. The genital apertures are unilateral. The worm is in a poor state of preservation and did not stain well.

The scolex (Text-fig. 47) is 160 $\mu$ long, including the length of the rostellum, by 260 $\mu$ broad across the suckers. The four suckers are circular in outline and measure 100–110 $\mu$ in diameter. Sucker spines were not seen. The rostellum, 65 $\mu$ long and 45 $\mu$ in diameter, bears a single row of 10 hooks which are not evenly spaced round the periphery therefore suggesting that there may have been some hooks lost. The length of the hooks is 18–19 $\mu$ and their shape can best be seen in Text-fig. 48.




Figs. 47 and 48. Dilepidid. Scolex (Fig. 47), and rostellar hooks (Fig. 48).

The only genitalia that can be made out with any certainty are the testes, which number 24–30, and which measure 45–75 $\mu$ × 23–38 $\mu$. In one segment there was a suggestion of double genitalia, but this clearly was not the normal arrangement.

Discussion. The worms show many features of the Dilepididae, but could belong to a wide range of genera. But for the shape of hooks, the data available from this worm agree very closely with those of *Anomotaenia mutabilis* (Rudolphi, 1819) Fuhrmann, 1907, even as to the order of host it infests. Owing to the lack of mature and gravid proglottides which can be described, identification further than the family is not possible.

## Genus ***KOWALEWSKIELLA*** Baczynska, 1914

### ***Kowalewskiella susanae*** n. sp.

(Text-fig. 49)

Host. *Tringa glareola* 9255.

Several worms are present in a good state of preservation. They measure up to 25 mm. long by 0·525 mm. in maximum breadth. The immature proglottides are slightly broader than long, but the mature proglottides become twice as long as they are broad. The genital apertures are irregularly alternating. The genital ducts pass between the dorsal and ventral excretory vessels.

The scolex measures 90–100 $\mu$ in diameter, but is bent and squashed so that the length cannot be measured accurately. The suckers are about 45 $\mu$ in diameter, but these too are squashed. Only three hooks were seen on the rostellum, of which only one could be measured, its length being about 8 $\mu$.

There are 21–30 testes (Text-fig. 49) arranged in two groups, one group lying anteriorly to the female genitalia and the other lying posteriorly. The number of testes in each group is approximately equal and the size of the testes is subject to wide variation measuring 45–65 $\mu$ × 35–60 $\mu$. There is neither an internal nor an external seminal vesicle present, the vas deferens, however, probably acts as an external seminal vesicle as it becomes greatly swollen with sperm in mature proglottides. The cirrus-sac is 92–98 $\mu$ long by 53–60 $\mu$ in diameter and is situated laterally, in about the middle of the proglottis. It opens into a well-developed genital atrium. In the mounted material, the cirrus is present only as a short papilla, but there is a convoluted ductus ejaculatorius still present in the cirrus-sac.

The ovary is distinctly bilobed, each lobe being separated by a relatively long isthmus. The lobes are irregularly lobular and, in proglottides where the cirrus-sac is well developed, the total breadth of the ovary is 150–250 $\mu$. The vitelline gland, lying posteriorly to the ovary, measures 55–90 $\mu$ × 34–52 $\mu$. Just in front of the vitelline gland, but dorsal to it and behind the ovary, is the shell-gland which has a diameter of 20–25 $\mu$. The receptaculum seminis lies between the cirrus-sac and the ovary and shows wide variation in size depending on the quantity of sperm present, the normal variation being 60–90 $\mu$ × 40–50 $\mu$.

Gravid proglottides were not found.

British Museum (N.H.) Reg. no. 1968.4.25.47–48.

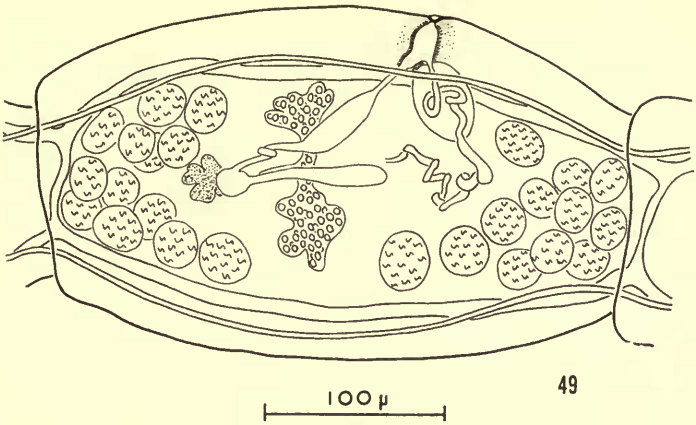



FIG. 49. *Kowalewskiella susanae* n. sp. Mature proglottis.

DISCUSSION. The present material agrees well with material from the same host described by Baer (1959) as *Kowalewskiella cingulifera* (Krabbe, 1869) Sandeman, 1959. Sandeman (1959*a*) re-erects the genus *Kowalewskiella* Baczynska, 1914, to contain all those species in which the testes are divided into two groups, one anterior to the female genitalia, and the other posterior. In accordance with this, he transfers *Choanotaenia glareolae* Burt, 1940, *Choanotaenia stagnatilidis* Burt, 1940, and *Choanotaenia hypoleucia* [*sic*] Singh, 1952, all to the genus *Kowalewskiella*. Furthermore despite the differences apparently inherent between these species and Krabbe's, species *cingulifera*, he regards them all, as well as *Kowalewskiella longiannulata* Bacyznska, 1914, as synonyms of *cingulifera*. Baer (1959) accepts this view and in a personal communication points out that " *K. cingulifera* forms a group within which variations appear to be considerable ". This assumption is presumably based on the fact that Baer (1959) described some worms from *Tringa glareola*, from the Belgian Congo, as *K. cingulifera*. As can be seen from the accompanying table (Table XI) if Baer's material is, in fact, *cingulifera* then there would be present very great variation within the species; more variation than can readily be accepted as existing in any one species. If the two species of Burt (1940), the species described by Singh (1952) and that of Baczynska (1914), are also considered as *cingulifera*, then this increases the already wide variation even more. Sandeman (1959*a*) does not outline his reasons for placing these various worms in synonymy with *cingulifera*, but it is doubtful if this sweeping treatment is justified in the present circumstances and, accordingly, it is here suggested that *cingulifera*, *longiannulata*, *glareolae*, *stagnatilidis* and *hypoleuca* are all separate species.

To these five valid species should also be added *Kowalewskiella bodkini* (Vevers, 1923) n. comb. (= *Raillietina* (*Skrjabinia*) *bodkini* Vevers, 1923), *K. buzzardia* Tubangui and Masiluñgan, 1937, and *K. susanae* n. sp. It is unfortunate that Krabbe's original description is not more complete, but it can be differentiated from any of the others on the large size of the scolex, and on the large number of rostellar hooks. *K. longiannulata* can be distinguished from the rest by the fact that it has a

## Table XI

Comparison of known species of *Kowalewskiella* with *K. susanae* n. sp. from Borneo.

| Species: | *cingulifera* (Krabbe, 1869) | *longiannulata* (Baczynska, 1914) | *glareolae* (Burt, 1940) | *stagnatilidis* (Burt, 1940) | *hypoleucia* (Singh, 1952) | *bodkini* (Vevers, 1923) | *bodkini* (Vevers, 1923) | *buzzardia* (Tubangui & Masiluñgan, 1937) | *cingulifera* (Baer, 1959, *nec* Krabbe, 1869) | *susanae* n. sp. |
|---|---|---|---|---|---|---|---|---|---|---|
| Descriptions taken from: | Krabbe (1869) | Baczynska (1914) | Burt (1940) | Burt (1940) | Singh (1952) | Vevers (1923) | Personal measurements of co-type material | Tubangui & Masiluñgan (1937) | Baer (1959) | |
| Strobila (length × max. breadth in mm.) | 100 × 1 | 30–40 × 0·54 | 39–41 × 0·66–0·83 | 70–120 × 1·15–1·3 | 35–40 × 0·42–0·46 | 50 × ? | 38–48 × 1·2 | 160 × 1·9 | 35 × 0·57 | 25 × 0·525 |
| Scolex (diameter in $\mu$) | — | 65 | 95 | 98–100 | 480–630 (=48–63?) | 135 | 108–136 | 400 | 91 | 90–100 |
| Rostellum (diameter in $\mu$) | — | 3·9 (=39?) | 37–46 | 41 | 43–56 | 50 | 48–55 | 130 | — | — |
| Rostellar hook (number) | ca. 40 | 28–30 | 36–40 (calculated) | 28 | 26 | 36 | — | 10 | 30 | — |
| Rostellar hook (length in $\mu$) | 4–5 | 52–60 (=5·2–6·0?) | 7 | 6 | 6–7 | 6 | — | 61–65 | 8–9 | 8 |
| Suckers (diameter in $\mu$) | — | 23 | 27–35 | 37 | 43–52 | 50 | 30–55 | 120 | 41 | 45 |
| Testes (number) | — | ca. 52 | 30–40 | 50–62 | 35–50 | 45–50 | 35–54 | 30 | 21–31 | 21–30 |
| Cirrus sac (length × diameter in $\mu$) | — | 93·6 × 46·8 | 188–222 × 62–70 | 170–204 × 48–60 | 215–279 × 64–73 | (120 × 60?) | 105–130 × 40–72 | 400 × 100 | 119 × 61 | 92–98 × 53–60 |
| Receptaculum seminis (length × diameter in $\mu$) | — | 96 × 46 | 250–275 × 140–155 | 196–210 × 75–108 | 189 × 146 | 150 × 70 | 120–150 × 120–150 | enlarged | large | 60–90 × 40–50 |
| Host | *Totanus calidris* | *Totanus stagnalis* | *Tringa glareola* | *Tringa stagnatilis* | *Tringa hypoleucos* | *Actitis macularia* | *Actitis macularia* | *Butastur indicus* | *Tringa glareola* | *Tringa glareola* |

small scolex, small cirrus-sac, but many testes. The two species described by Burt (1940) are well separated on the constant difference in number of testes and in view of the fact that the cirrus-sac in *glareolae* appears to be significantly larger than that in *stagnatilidis*, even though the outside lower limit of the former overlaps with the upper limit of the latter. Singh (1952), describes the scolex of *hypoleuca* as 0·634–0·672 mm. × 0·48–0·63 mm. These measurements, however, are at variance with the figure he draws and the difference does not seem to be merely a matter of a factor of 10. The suckers are described as 0·043–0·052 mm. in diameter, while the diameter of the scolex is, as stated above, 0·48–0·63 mm. In his drawing, Singh figures four suckers on the scolex and the sizes of the suckers drawn are such that it would be possible to place three suckers, side by side, and still not project beyond the side of the scolex. Thus, the scolex diameter must be about 130 $\mu$ or 0·130 mm. According to the scale given, the breadth of the scolex across the suckers is about 110 $\mu$. Thus, it seems unlikely that the measurements given by Singh refer to the scolex of this species at all and should probably be completely ignored. However, the large size of the cirrus-sac and the large number of testes all serve to separate it from any of the other species. *K. bodkini* resembles both *glareolae* and *stagnatilidis* in many respects, but can be separated from both species on account of the size of the cirrus-sac. In *bodkini*, even the largest cirrus-sac present, which was measured personally from the holotype and paratype material, is still 40 $\mu$ smaller than the lower limit quoted by Burt (1940) for *stagnatilidis*. Finally, the small number of testes in *susanae* n. sp. serves to separate it from any of the other species. The small cirrus-sac also separates it from *glareolae*, *stagnatilidis* and *hypoleuca*.

The new species described above has been named *susanae* in grateful recognition of the help received from Miss Susan Burt in the preparation of this manuscript.

## Genus ***ASCOMETRA*** Cholodkovsky, 1913

### *Ascometra* (?) sp.

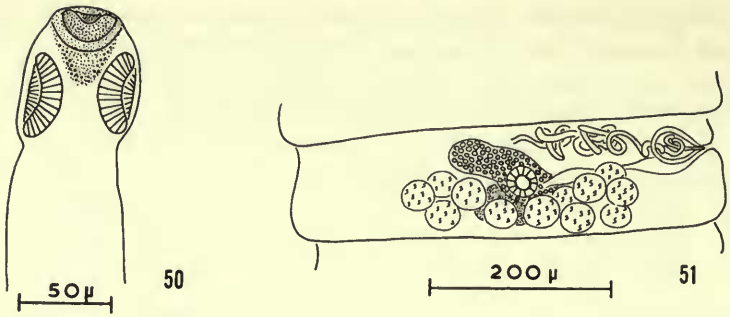
(Text-figs. 50–52)

Host. *Centropus toulou* 8927.

The strobila measures 55 mm. long by 0·9 mm. in maximum breadth. The immature and mature proglottides are up to three times as broad as they are long, while the length of the gravid proglottides is up to twice the breadth. The genital apertures are almost unilateral, only 5% of the apertures occurring on the other side. The apertures in this 5% all occur singly.

The scolex (Text-fig. 50) is 82 $\mu$ long and 62 $\mu$ in diameter. There may be four suckers present, but the only two seen clearly are 45–50 $\mu$ in long diameter. Sucker spines are not present. For a description of the rostellum (?) see the discussion following this description.

There are 6–13 testes (Text-fig. 51) lying mainly posteriorly to the ovary although they may come to lie laterally in some proglottides. The testes measure 37–52 $\mu$ × 30–40 $\mu$. The cirrus-sac, 52–64 $\mu$ long by 30–50 $\mu$ in diameter, is situated laterally about one-third the length of the proglottis from the anterior margin. The cirrus,




FIGS. 50 and 51. *Ascometra* (?) sp. Scolex (Fig. 50) and mature proglottis (Fig. 51)

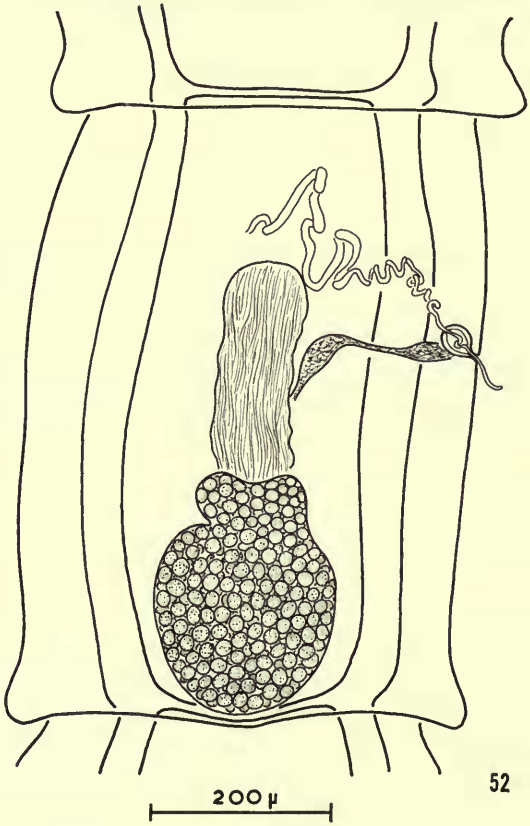



FIG. 52. *Ascometra* (?) sp. Gravid proglottis.

apparently unarmed and short, could be seen in a few proglottides projecting from the cirrus-sac. The largest cirrus seen was 35 $\mu$ long by 4$\mu$ in diameter.

The bilobed ovary tends to be slightly displaced towards the aporal side of the proglottis but as it is not lying flat in the majority of proglottides, its full extent is difficult to determine accurately. Immediately behind the isthmus of the ovary is the ovoid vitelline gland which measures 50–75 $\mu$ × 45–60 $\mu$. The vagina, which

opens into the genital atrium posteriorly to the opening of the cirrus-sac, is relatively short, opening into a small receptaculum seminis which lies almost immediately behind the cirrus-sac. The receptaculum seminis measures 35 $\mu$ × 20 $\mu$.

The uterus (Text-fig. 52) exists as a simple sac-like structure initially which lies in the posterior half of the proglottis within the medulla and not extending beyond the the excretory vessels. Just in front of the uterus lies the paruterine organ which gradually surrounds the uterus and rounds it off into an almost spherical structure.

Discussion. The structure of the scolex is very difficult to ascertain as it is lying in such a position that what at first sight looks like a rostellum may in fact be a third sucker superimposed on a fourth one. In the event that the scolex bears four suckers and no rostellum, it is almost certain that the worm belongs to the genus *Ascometra* Cholodkovsky, 1913, or perhaps to the genus *Orthoskrjabinia* Spassky, 1947. If the genital apertures are considered as being unilateral, thereby ignoring the 5% of genital apertures which appear on the " wrong " side, the worm should belong to the genus *Ascometra*; but if, on the other hand, the genital apertures are simply considered as irregularly alternating, this character would place the worm in Spassky's genus *Orthoskrjabinia*. In view of the fact that in neither of the two mentioned genera does there exist a worm which agrees sufficiently well with the present worm to warrant identification with it, and in view of the fact that the worms are ton in good enough state of preservation to allow a full description, it has been thought best that the present material be left unidentified until such a time as more material from *Centropus toulou* becomes available.

## Genus ***NOTOPENTORCHIS*** Burt, 1938

### ***Notopentorchis collocaliae*** Burt, 1938

(Text-figs. 53–55)

Host. *Apus affinis* 8784.

The worm is 20 mm. long and 0·48 mm. in maximum breadth. The proglottides are all, except for some of the most gravid ones, broader than long, the ratio of breadth to length varying from 4 : 1 to 3 : 2. The genital apertures are irregularly alternating and the genital ducts pass ventrally to the excretory vessels.

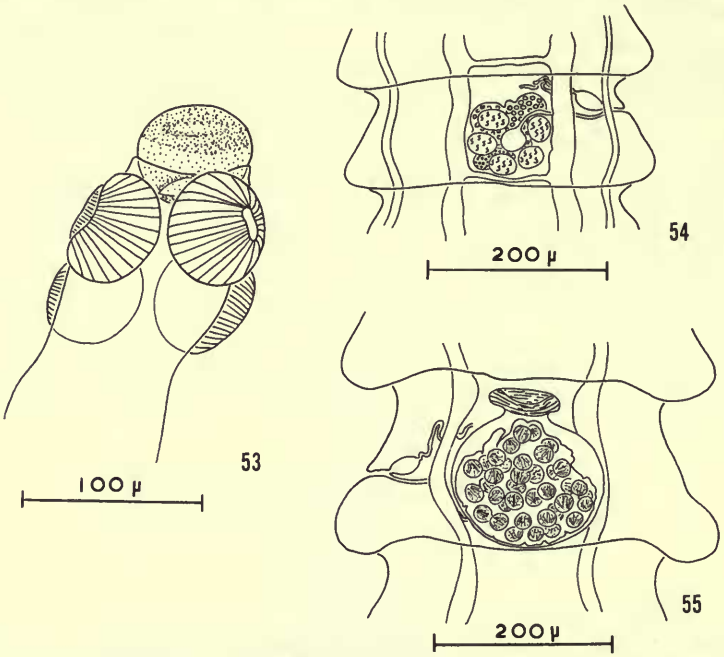
The scolex (Text-fig. 53) measures 110 $\mu$ in diameter and has a length, including the length of the rostellum, of 120 $\mu$. The suckers are 65–70 $\mu$ × 50–55 $\mu$ and are unarmed. The rostellum, 60 $\mu$ long by 70 $\mu$ in diameter, is also unarmed but it is presumed that the hooks of the rostellum have been lost.

There are usually five testes (Text-fig. 54), but an occasional proglottis may contain four or six testes. These are situated posteriorly and laterally to the female genitalia with a tendency also to overlie parts of the ovary and the vitelline gland and they measure 25–30 $\mu$ × 18–22 $\mu$. The cirrus-sac is small and most easily seen in gravid proglottides where it measures 30–35 $\mu$ in length by 16–20 $\mu$ in diameter.

The ovary, lying in the centre of the proglottis, is large and irregularly lobular, while the vitelline gland, which lies posteriorly to the ovary, is also well developed and measures 40–45 $\mu$ in diameter. Situated above the posterior part of the ovary is the shell-gland which has a diameter of 30–35 $\mu$. The vagina, which opens into

the genital atrium posteriorly to the opening of the cirrus sac, passes ventrally to the excretory vessels and opens into a receptaculum seminis which, in gravid proglottides where it reaches its maximum size, measures 24–33 $\mu \times$ 16–20 $\mu$.

The uterus is initially present as a simple sac which rounds off to form a sphere, 120–180 $\mu$ in diameter (Text-fig. 55). There are 20–35 eggs per proglottis and the contained oncospheres measure 30–38 $\mu \times$ 24–30 $\mu$. The hooks of the oncosphere are of two different sizes: the two lateral pairs are smaller, measuring 13–15 $\mu$ in length while the medial pair is larger, measuring 16–20 $\mu$ in length.




Figs. 53–55. *Notopentorchis collocaliae* Burt, 1938. Scolex (Fig. 53), mature proglottis (Fig. 54), and gravid proglottis (Fig. 55).

Discussion. The present material agrees very closely with the Ceylon material described by Burt (1938*a*) as *Notopentorchis collocaliae* for which he created a new species and erected a new genus. Baer (1959), however, transfers to the genus *Notopentorchis* Burt, *Paruterina javanica* Hübscher, 1937 and *P. bovieni* Hübscher, 1937 and places *N. collocaliae* as a synonym of what is now *Notopentorchis javanica* (Hübscher, 1937). In Burt's paper, the number of rostellar hooks is not given and Baer estimates the number, from the drawing of the scolex, to be about 50. Through the kindness of Mr. D. R. R. Burt, I have been able to examine the type material of *Notopentorchis collocaliae* and find there to be between 30–35 hooks, probably about 32. As there are at least 50 hooks in *javanica*, according to Baer who re-examined the type material of Hübscher, this would seem to represent a valid differentiating character. This difference, taken with the significant difference in the size of the cirrus-sac, undoubtedly separates these two worms and, accordingly, it is proposed here that *Notopentorchis collocaliae* is a valid species and should not

be regarded as a synonym of *N. javanica*. Singh (1952) describes the species *Notopentorchis micropus* from *Micropus affinis*. Although his species differs from *collocaliae* " in the shape of the hooks, the size of the hooks of the two crowns, size of cirrus pouch, shape of ovary and development of uterus and paruterine organ ", it does not differ from Hübscher's species, *javanica*, with which Singh did not compare it. The apparent difference in number of testes (5 in *micropus* and 8–10 in *javanica*) is not a valid difference as re-examination of Hübscher's type material of *javanica* by Baer indicated that there were never 8–10 testes but only 5. Mokhehle (1951) creates the species *Sphaeruterina caffrapi* which appears to differ from *Notopentorchis javanica* only in the fact that the genital ducts pass dorsally to the excretory vessels instead of ventrally. Baer (1959), however, points out that while the genital ducts are described as passing dorsally to the excretory vessels, they are drawn as passing ventrally. Mokhehle (1951) described a second species of *Sphaeruterina*, namely *S. dikeniensis*, and again describes the genital ducts as passing dorsally to the excretory vessels but draws them as passing ventrally. Baer assumes that Mokhehle is correct in his drawing but wrong in his description and believes that both worms should be in the genus *Notopentorchis*, the first one as a synonym of *javanica* and the second, *Sphaeruterina dikeniensis*, as a synonym of *Notopentorchis vesiculigera* (Krabbe, 1882). The accompanying table (Table XII) best illustrates the differences between the four valid species of *Notopentorchis*.

TABLE XII

Valid species of *Notopentorchis* compared with material from Borneo.

| Species: | *vesiculigera* Krabbe, 1882 | *bovieni* Hübscher, 1937 | *javanica* Hübscher, 1937 | | *collocaliae* Burt, 1938 | Borneo material |
|---|---|---|---|---|---|---|
| Descriptions taken from: | Krabbe (1882) | Hübscher (1937) | Hübscher (1937) | Baer (1959) | Burt (1938*a*) | |
| Strobila (length × max. breadth in mm.) | 100 × 1·5 | 78 × 0·918 | 26·5 × 0·5 | 25 × 0·59 | 26 × 0·29 | 20 × 0·48 |
| Scolex (diameter in $\mu$) | — | 408 | 228 | 183–260 | 150 | 110 |
| Rostellum (diameter in $\mu$) | — | 252 | 135 | 90–100 | 82 | 70 |
| Rostellar hooks (number) | 50 | 70 | 44–48 | 50 | 30–35 (personal count from type material) | hooks lost |
| Rostellar hooks (length in $\mu$) | 37–46 & 20–26 | 60 & 30 | 25–28 | 30–31 & 25–26 | 27 & 24 | hooks lost |
| Suckers (diameter in $\mu$) | — | 180–228 | 102 | 68–75 × 57–75 | 75 | 65–70 × 50–55 |
| Testes (number) | — | 9–12 | 8–10 | 5–6 | 5 | 5 (4–6) |
| Cirrus sac (length × diameter in $\mu$) | — | 150–170 × 40 | 110–120 × 40–50 | 57–68 × 23 | 35 × 30 | 30–35 × 16–20 |
| Oncospheres (diameter in $\mu$) | — | 39 × 24 | 27–30 | 31–32 | 28 | 30–38 × 24–30 |
| Oncosphere hooks (length in $\mu$) | 17–19 | 18 | 15 | — | 19 | 13–15 × 16–20 |
| Host | *Hirundo rustica Cypselus apus* | *Macropteryx longipennis* | *Macropteryx longipennis* | *Apus caffer* | *Collocalia unicolor* | *Apus affinis* |

## Family **ACOLEIDAE** Fuhrmann, 1907
## Genus ***GYROCOELIA*** Fuhrmann, 1899
## ***Gyrocoelia perversa*** Fuhrmann, 1899
## (Text-figs. 56–59)

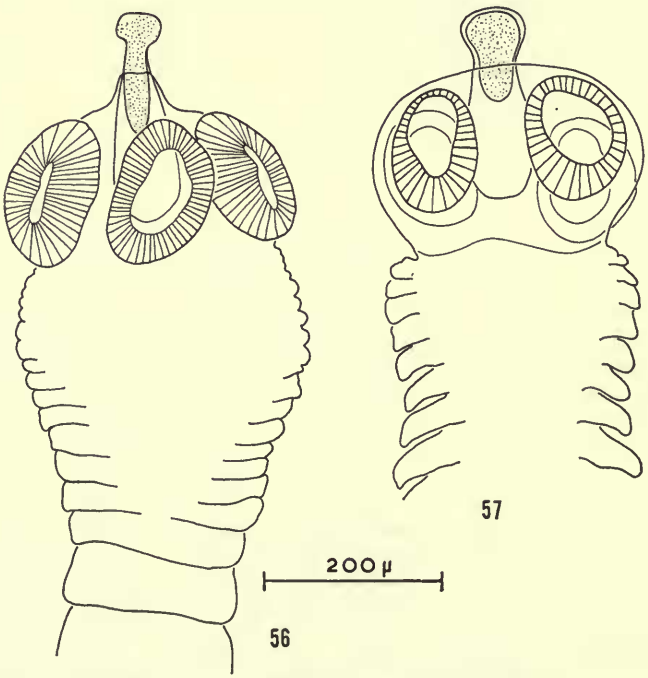
*Gyrocoelia paradoxa* (von Linstow, 1906) Fuhrmann, 1908.
*Gyrocoelia milligani* Linton, 1927.
*Gyrocoelia pagollae* Cable and Myers, 1956.

Host. *Charadrius leschenaultii* 8999; 9334.

One full mature " female " strobila was found in host 8999, and two small, barely mature worms—one male and one " female "—were found in host 9334.

The scolex (Text-figs. 56 and 57) measures 290–325 $\mu$ in diameter by 250–280 $\mu$ in length including the length of the rostellum. The suckers are oval in outline and measure 145–170 $\mu \times$ 100–125 $\mu$. No sucker spines were seen. The rostellum measures 150–250 $\mu$ from the top of the apical cushion to the bottom of the rostellar sac and the diameter of the apical cushion is 50–80 $\mu$. No rostellar hooks were seen.

The male strobila (Text-fig. 58) is not fully mature although, in the distal part of the strobila, several cirri can be seen in various stages of extrusion. The length of the strobila is 8 mm. and the maximum breadth is 0·9 mm. The testes are present in a compact group about the centre of the proglottis, but are so crowded together that it is not possible to make an accurate count of their number. There appear to be,

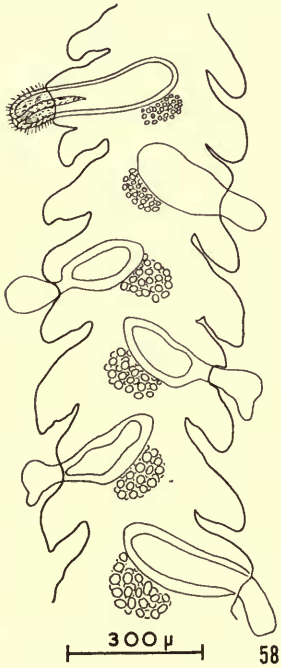


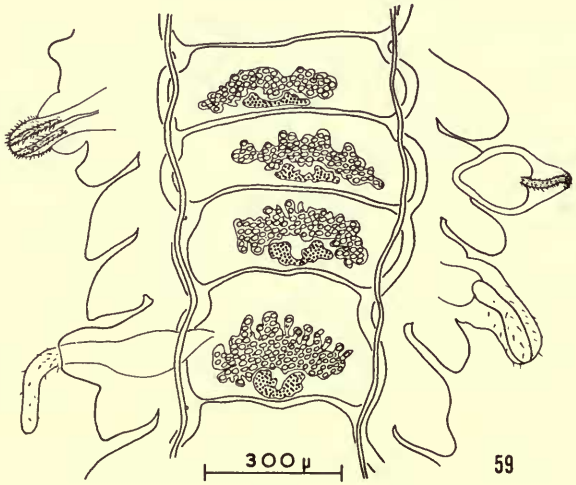

Figs. 56 and 57. *Gyrocoelia perversa* Fuhrmann, 1899. Scolex with everted rostellum (Fig. 56) and scolex with retracted rostellum (Fig. 57).

however, about 30 testes, the maximum diameter of the most mature testes present being 30–40 μ. The cirrus-sac measures 240–280 μ × 120–130 μ and passes between the ventral and the dorsal excretory canals. The conical cirrus measures about 250 μ in its extended form, has a diameter of 75 μ at its base, and a diameter of about 35 μ at its apex. During the early part of its extrusion, the long spines present on the proximal quarter of the cirrus are easily seen and these measure 10–15 μ in length when measured from a whole mount.

The smaller " female " strobila is very similar in external dimensions to the small male, while the larger " female " (Text-fig. 59) measures 53 mm. long by 2·5 mm. in maximum breadth. The ovary is a little over 500 μ across by 50–100 μ. The elongated vitelline gland measures 230–250 μ × 30–45 μ. The " receptaculum seminis " could be seen lying between the ovary and the vitelline gland. In the larger of the two worms, the cirrus-sac measures 420–500 μ × 110–150 μ; while in the smaller worm the cirrus-sac is 300–320 μ × 120–140 μ. The eggs, present only in the larger worm, measure 68–73 μ × 35–40 μ while the contained oncospheres are 20–30 μ in diameter. The hooks of the oncosphere were not examined as squash preparations, but on a whole mount these appeared to be about 8 μ long.

The muscular system is very well developed and comprises 100–150 large bundles of longitudinal muscle fibres in two poorly separated layers. Each bundle contains up to 100 individual muscle fibres. The transverse muscles lie between the longitudinal muscle bundles and also round the central medulla. Close to the cuticle lie further individual longitudinal muscle fibres interspersed with large parenchyma cells.




FIGS. 58 and 59. *Gyrocoelia perversa* Fuhrmann, 1899. Part of a male strobila (Fig. 58) and part of a " female " strobila (Fig. 59).

Discussion. The present material agrees reasonably closely with that described by Baer (1959) as *Gyrocoelia perverse* Fuhrmann, 1899(*b*). Baer places all known species of *Gyrocoelia* plus *Infula burhini* Burt, 1939(*b*), into two groups. The first of these groups contains *Gyrocoelia australiensis* Johnston, 1912; *G. fausti* Tseng-Shen, 1933; *G. kiewietti* Ortlepp, 1937; *Infula burhini* Burt, 1939; and *Gyrocoelia albaredai* López-Neyra, 1952, all of which become synonymous with *Gyrocoelia crassa* (Fuhrmann, 1900) Baer, 1940. The second group contains *Gyrocoelia paradoxa* (von Linstow, 1906) Fuhrmann, 1908; *G. milligani* Linton, 1927 (see also Webster, 1943*b*); and G. *pagollae* Cable and Myers, 1956, all of which become synonymous with *Gyrocoelia perversa* Fuhrmann, 1899.

Although at first sight there appear to be several differences between the two groups, few of these are significant. Perhaps the most striking differences are found in the size of cirrus-sac, the number of testes and the diameter of the scolex. In *perversa*, the cirrus-sac tends to be smaller and measures up to about 400 $\mu$ × 137–146 $\mu$, while in *crassa*, the length of the cirrus-sac reaches up to 650 $\mu$ and its diameter is 195–260 $\mu$. In *perversa* there tend to be fewer testes, numbering 20–30, whereas in *crassa* the number ranges from 30 to 50 per segment. Although the upper number of testes in *perversa* coincides with the lower number of testes in *crassa*, the average number of testes found in any one worm can usually place it unambiguously into one or other of the two species. Finally, in *perversa* the diameter of the scolex is about 320 $\mu$ whereas in *crassa* it is considerably greater, measuring 411–457 $\mu$. It is not unlikely that there exists a graded series of forms and that one worm may exhibit features in common with both species. For instance, the present material possesses about 30 testes and thereby lies about half-way between *perversa* and *crassa*. Another feature which would place it in this anomalous position is the size of the cirrus-sac, particularly that of the large " female " strobila which, although far from reaching the upper limit of size of cirrus-sac found in *crassa*, is nevertheless substantially bigger than the cirrus-sac described for *perversa*. The size of the scolex, the diameters of the suckers, and, to a certain extent, the overall size of the worm all indicate that it is *perversa*.

Owing to the fact that the present material possesses no rostellar hooks, it was first thought that the worms belonged to the genus *Infula* Burt, 1939. The two main features of difference between *Infula* and *Gyrocoelia* are that *Infula* is dioecious and there are no rostellar hooks whereas in *Gyrocoelia* there are rostellar hooks, and initially the worm was considered by most as a normal hermaphrodite worm. Early workers described *Gyrocoelia* as possessing testes and ovaries in the same strobila and, furthermore, in some cases actually figured them together in the same proglottis. However, Baer (1959), by re-examining much of the type-material, has been able to show that testes do not occur in the same strobilae as ovaries. Furthermore, Baer examined the type-material of *Infula burhini* Burt, 1939, but was unable to substantiate Burt's hypothesis that the structure corresponding to the cirrus-sac in the male, functioned as a vagina in the female, particularly as he could not find sperm in the proximal portion of the " vagina " where it should undoubtedly be in the event of that structure functioning as a vagina. In view of this, and in view of the fact that it is generally recognized that the rostellar hooks of *Gyrocoelia* are

highly caducous, Baer felt justified in treating *Infula* as a synonym of *Gyrocoelia* and making *Infula burhini* a synonym of *Gyrocoelia crassa*. The fact that sperm are found in the " receptaculum seminis " is explained by Baer with the hypothesis that the female strobilae are cryptohermaphrodite and that sperm are produced by testicular tissue which is present in the walls of the " receptaculum seminis ".

Although Baer considers that *Infula* should belong to the genus *Gyrocoelia*, on the grounds stated, it is by no means improbable that *Infula* may well be a valid genus, principally on the basis of its lacking rostellar hooks. Recognizing that rostellar hooks may easily be lost in fixing and preserving worms, towards the end of his discussion on *Infula burhini*, Burt (1939*b*) states the following:

" The worms described in this paper were obtained in the field from birds shot for their parasites. They were fixed in Bouin's fluid on the spot, hence their state of preservation and fixation is good. Cestodes collected under these conditions and before fixation allowed to detach themselves from the wall of the gut by placing the opened gut in water, very rarely lose their rostellar hooks. Thus one has little hesitation in accepting the absence of hooks in the six specimens as being a diagnostic character. *Infula* is most nearly allied to *Shipleya* and *Gyrocoelia*, and is distinguished from these, apart from its dioecious character, by the character of the rostellum. The rostellum is absent in *Shipleya*, a fact which was ascertained by Fuhrmann from sections of the scolex; it is present and characteristically armed in *Gyrocoelia*; and present but unarmed in *Infula*."

Coil (1955*b*) describes a new species of *Infula*, namely *I. macrophallus*, and in a later paper (Coil, 1963) he discusses the validity of the genera *Gyrocoelia* and *Infula*. His conclusions, which are based on careful examination of worms from freshly killed hosts, indicate that not only is the scolex of *Infula* consistently unarmed, but that there are highly significant differences in the egg membranes of members of the two genera. These differences are elegantly shown by using various histochemical techniques such as those used by Ogren (1958, 1959*a* and *b*, and 1961).

Burt has recently made a large collection of worms from wading birds in North America and it is hoped that examination of this new, carefully fixed and preserved material, will throw further light on the genus *Infula* particularly in relation to the cryptotestes suggested by Baer.

From the same host species, namely *Charadrius leschenaultii*, there were found what appear to be three different worms all of which, however, almost certainly belong to one or other of the families Acoleidae, Progynotaeniidae, and Dioecocestidae. Brief descriptions of them are given here due to their probable relationship with *Gyrocoelia* and they are described simply under the headings of Species 1, Species 2 and Species 3.

*Species* 1.

This is represented by three small worms in poor state of preservation which probably belong to the genus *Progynotaenia*, or perhaps *Andrepigynotaenia*. The longest worm measues 6 mm. long by 0·7 mm. in maximum breadth. The genital apertures are irregularly alternating.

The scolex has a diameter of 150 $\mu$ and is 150 $\mu$ long, the length being taken to

include the length of the rostellar sac. The four suckers are approximately 75 $\mu$ in diameter but appear to be degenerating. No sucker spines were seen. The rostellum measures about 60 $\mu$ long, the rostellar sac about 90 $\mu$ long, and the apical cushion has a diameter of 52 $\mu$. No rostellar hooks were seen, but there appear to be 11 or 12 scars present on the rostellum which may well mark the sites of hooks that have been lost.

Although the worm is not in a very good state of preservation there appear to be about 7 testes, the range possibly being 6–10, which have a diameter of 30–40 $\mu$. These were best seen lying alongside the developing uterus and were scarcely visible in any but two proglottides. The cirrus-sac is 150–200 $\mu$ long by 70–80 $\mu$ and is not fully developed until the uterus is well formed and the ovary and vitelline gland have both disintegrated. There does not appear to be either an external nor an internal seminal vesicle, the vas deferens lying slightly twisted and swollen outside the cirrus-sac and the ductus ejaculatorius lying in a few loops in the proximal portion of the cirrus-sac.

The ovary measures about 125 $\mu \times 90$ $\mu$ just before it starts to enlarge with what appear to be fertilized eggs. The vitelline gland, situated ventrally and posteriorly to the ovary, is more or less spherical with a diameter of about 70 $\mu$. The receptaculum seminis is large, measuring up to 230 $\mu \times 110$ $\mu$, and can be seen in several proglottides as a swollen sac full of sperm.

There are no fully-gravid proglottides but in the more mature proglottides, the uterus can be seen as a large sac-like structure almost completely filling the medulla of the proglottis.

*Species* 2.

This is represented by one worm, 9 mm. long and 0·52 mm. in maximum breadth. The proglottides tend to be triangular in shape, longer than broad initially but becoming slightly broader than long. The genital apertures are regularly alternating.

The scolex has a diameter of 175 $\mu$ across the suckers and a length of 180 $\mu$ including the length of the rostellum. The four suckers are 85–95 $\mu$ in diameter and appear to be unarmed. The rostellum also apparently unarmed, measures 144 $\mu$ from its tip to the bottom of the rostellar sac.

The strobila appears to comprise solely male proglottides, but owing, perhaps, to the poor state of preservation, no testes were seen. The cirrus-sac is large and in many of the more distal proglottides, could be seen projecting well beyond the lateral margin of the strobila. It measures 315–350 $\mu$ long by 110–130 $\mu$ in diameter and in early proglottides can be seen to contain a large, profusely spined, cirrus. In the later proglottides, when the cirrus, which reaches over 300 $\mu$ in length, has been extruded, the spines are no longer visible and presumably have been lost.

No other anatomical features could be made out.

*Species* 3. (Text-fig. 60).

This species is represented by a single worm with a scolex which bore three hooks. The material is in an advanced state of decomposition and the only data of any significance is the shape and size of the hooks.

Measured under oil immersion in a squash preparation, the hooks (Text-fig 60) are 85 $\mu$, 86 $\mu$ and 89$\mu$ long, although one, the largest, is slightly twisted.

Discussion. Although Webster (1951) gives a useful table of species in the genera *Progynotaenia* and *Proterogynotaenia* and Sandeman (1959*b*) gives a more recent review of the genus *Proterogynotaenia*, none of the above three species could be identified. There is only one worm described in the genus *Andrepigynotaenia* Davies and Rees, 1947, and that has many more testes (58–70) than is apparent in any of the above. It may be that one or more of the above three represents a new species but, as the material is neither in good condition nor complete, the erection of any new species is hardly justified.

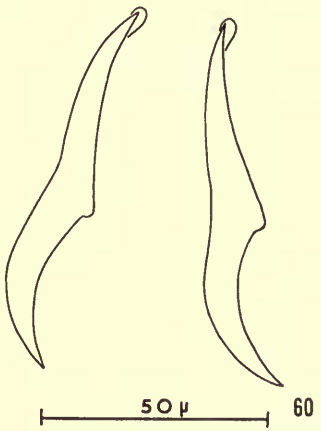



Fig. 60. Species 3. Rostellar hooks.

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